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INDEX TO VOLUME XIV.

APPENDICES.

Notices to Correspondents, &c., &c.

The Astronomical Register.

No. 157. JANUARY. 1876.

ROYAL ASTRONOMICAL SOCIETY.

Session 1875—76.

Second Meeting after the Long Vacation, December 11th, 1875.

Professor Adams, F.R.S., *President*, in the Chair.

Secretaries—Mr. Dunkin and Mr. Ranyard.

The minutes of the last meeting were read and confirmed.

Mr. Ranyard reported that 50 presents had been received by the Society since their last meeting in November. Amongst them were some valuable books which had been given by Lord Lindsay. He thought that the special thanks of the Society were due for this present. Among them was Vieta's *Canon Mathematicus seu ad Triangula*, fol. Paris, 1579, a very handsome copy of a very rare book, and Ptolemy's *Almagest*, fol. 1579, the *Editio Princeps*, also a rare book.

Professor Adams: The special thanks of the Society are I think due to Lord Lindsay, for his very valuable present. The Vieta is I know a very valuable book. (Applause.)

Mr. Ranyard: I hope it will stimulate other Fellows to give any unique works they may have to the Society. It is very important that we should have a complete library of reference books. Such works would be more useful, I think, in our library than in private libraries. (Laughter.)

The special vote of thanks to Lord Lindsay was carried unanimously.

The following candidates for the fellowship of the Society were balloted for and duly elected :—

Señor Augusto T. Arcimis, Cadiz.

Lieut. Cyril Corbet, R.N., of Cloudesley, Bittern, Southampton.

Lieut. C. B. Neate, R.N., Royal Observatory, Greenwich.

Francis Murray Newton, Esq., Barton Grange, Taunton.

William Philip Snell, Esq., Belmont, near Havant.

William E. Wilson, Esq., Daramona, Streete, Rathowen, Ireland.

Mr. Talmage: Before we begin the reading of papers, may I be allowed to ask a question? I wish to enquire whether the Council have taken any steps to stop the fraudulent use of the letters "F.R A.S.," more particularly with reference to the case of one individual who goes "stumping" the country with a title to which he has no right, having been expelled from the Society. I think we ought to take some notice of the matter, and I am prepared to move a resolution on the subject.

Mr. Ranyard: You will be quite in order if you make the motion at the General Meeting. You can, if you like, give notice of your intention to make such a motion now.

The President: Yes, that would be more regular.

Mr. Talmage: But perhaps you would answer my question as to whether the Council has taken any step.

The President: No: we have not done anything as yet.

Mr. Dunkin: As the Secretary of the Society I have written to several periodicals in which I have seen the names of certain persons using the title, but I have received no replies to my letters, and at last I have given up writing, because it is only wasting my time and the Society's postage stamps. (Laughter.)

Mr. De la Rue: Perhaps Mr. Talmage would be in order if he requests the Council to communicate with the gentleman alluded to, because there are several cases of the kind in which a persistent use is made of the initials denoting the fellowship of this Society by persons not belonging to it, and it is really quite time a stop should be put to it, but it is very difficult to do so I know.

Mr. Dunkin: I think the case in question arises in this way, that the individual was formerly a Fellow of this Society, and has a lot of old notices of lectures on hand, and when he wishes to give a lecture he sends out a copy of an old prospectus which he used when he was a Fellow, and consequently the society which accepts his offer thinks him still a Fellow. I must say I have on several occasions written to secretaries of societies, but they take no notice of my letters.

Capt. Noble: Dr. Kenealy signs himself "Q.C." to this instant. (Laughter.)

Professor Pritchard: I may merely mention that I had the honour of officially expelling that gentleman from the Society

(Cries of "Name, Name.") Well, Sir Somebody Bennett, I mean. (Laughter.)

Mr. Burton read a paper *On the Southern Nebula* 30 (*Bode*) *Doradûs and the Nebula about η Argûs.* He said it occurred to him when engaged at Rodriguez, on the observations of the transit of Venus, that he would study with an instrument of his own the present structure of the remarkable nebulæ which had been so closely observed by Sir John Herschel. He had, therefore, made as careful drawings as his time would permit of 30 Doradûs and η Argûs, with a 12-inch silver on glass reflector. He showed his drawings to the meeting, and said that he had not had an opportunity of comparing them with Sir John Herschel's drawings until after his return to England, and now after a careful comparison he was not disposed to think there had been any *great* change in these two nebulæ since the date of Sir J. Herschel's observations.

Mr. Ellery: I dare say members of the Society will recollect that we, at Melbourne, have paid great attention to some of the larger nebulæ in the southern hemisphere, more particularly to those described in Sir John Herschel's work. The two nebulæ to which Mr. Burton has drawn our attention are these which have received the greatest attention, and I am not sorry to have the opportunity of stating what we have found with regard to the nebula about η Argus. The first thing that struck every one who saw it was the entirely different appearance it presented to that which is figured in Sir John Herschel's book, and the conclusion was naturally come to that there had been a very great alteration in the structure of the nebula since Herschel's time, not only with regard to the character and figure of the nebula, but also in the relative positions of some of the stars involved in it.* Mr. Burton has drawn Eta just close by what we call the *promontory;* but Eta is another star altogether outside the nebulosity. But what I wish to call attention to is this, that in Herschel's drawing you will find the *nebulosity* comes across the vacuity; when we first saw it with the 4-foot reflector it was altogether a different thing. The two promontories approached each other; while the nebulosity, which Mr. Le Sueur has described, appeared to be absorbed. Two years after the first drawing was made another was completed (now we have four complete drawings altogether); when the second was completed the "bridge" was quite traceable, and by placing the spectroscope across any part of this bridge we get the nitrogen

* [Note by Mr. Burton.—In my sketch η Argûs is represented completely outside the nebulosity, but it appears to have preserved its position relatively to the small neighbouring stars, all of which may be recognised in Sir John Herschel's drawing.]

lines of the nebula, showing that there really was nebulosity: and it is evident from our observations that a constant change is going on in the nebula—the most remarkable changes, that even a casual observer would notice if he looked at it one year and then again two years afterwards. Then η Argûs is now a star of the 6th magnitude. I don't know whether the Society will recollect what occurred with regard to this star some four or five years ago: we got in the spectrum of η Argûs on several occasions during the space of several weeks, a bright yellow line and occasionally a red line. I saw this myself four or five times, and Mr. Le Sueur saw it night after night. After this had been seen five or six weeks it disappeared and we have never seen the bright lines in that star since. The nebula is well worthy of frequent observation with large apertures; the changes are so well marked and so undoubted. Now, with regard to 30 Doradus, that is another instance where the changes are remarkable, we have made three drawings with the great telescope, the changes are decidedly progressive; those who become familiar with nebulæ notice at once the difference. There is in this nebula a great deal of what we have called interlacing rings, or little loops. I see that Mr. Burton has sketched some of them in his drawing. These loops, we find, are continually altering. At first we found that they lapped over or involved one another much more than they do at present. Besides these nebulæ we find that the smaller class are continually changing. We have not made so many observatious of the great nebula in Orion, because Lord Rosse has made such magnificent drawings of it; we have kept our forces more for the larger southern nebulæ which cannot be observed at the northern observatories.

Mr. Huggins: With reference to the variability of the bright line of η Argûs, it may be of interest to state that in the spectrum of the variable star in Cassiopeia, the bright line is much more distinctly seen at some times than at others.

The President: These observations that Mr. Ellery has called our attention to are of the utmost importance, and I think we cannot but accept the evidence of the rapid changes he has described.

Mr. Ranyard: I would ask, has Mr. Ellery compared Father Secchi's drawing of the nebula in Orion with Lord Rosse's drawing, and if so whether he has noticed the great differences that there are between those two apparently carefully executed drawings—not only as to the smaller details but also as to the great features of the nebula? My faith has, I must say, been a great deal shaken as to the possibility of mapping with any degree of exactitude details like those of a nebula.

Mr. Huggins pointed out to Mr. Ellery the drawings of Padre Secchi and the Earl of Rosse, which hang side by side in the meeting room.

Mr. Ellery: I have not seen until now Father Sechi's drawing. We have many a time observed the nebula of Orion and made many sketches. We have always found Lord Rosse's drawing to be a splendid representation of the nebula, but we fancied it was a little too hard, but that was inevitable on account of the difficulty of reproducing such a soft outline. I believe whatever we do in the shape of drawing nebulæ, we are sure to exaggerate them, and that is one of the great difficulties in our way and prevents us publishing the results of our observations. We want to hit upon a good method of portraying these as we see them. I can easily imagine, as regards the soft outline of the two drawings, that they are sure to differ a great deal; but this (Secchi's) is so different from Lord Rosse's that it appears to me as it would with the Melbourne reflector considerably out of focus. This does not convey to me the idea of the nebula nearly so well as Lord Rosse's drawing.

Mr. De la Rue: The telescope with which Secchi's drawing of the nebula of Orion was made would appear by comparison with Lord Rosse's only as a finder, and consequently we should expect to see a great difference in the drawings. In the one, only a general outline, but in the other the detail, seen in Lord Rosse's telescope, has been filled in, therefore, you can hardly compare Secchi's drawing with Lord Rosse's. It has occurred to me whether the appearances described by Mr. Ellery in 30 Doradus might not be accounted for by the rotation of the nebula. They look to me to be due to a change of perspective.

Mr. Ellery: Yes, there has been a suspicion that there might be rotation round a central star, but one or two remarkable loops are always the most prominent features.

Mr. De la Rue: I mean round an axis vertical in reference to the position of the nebula as shown on the drawing.

Mr. Ellery: Oh yes, that would be possible, but there are so many changes from Sir John Herschel's drawings, that it becomes very interesting to compare them with the recent ones. There has been a long gap between Herschel's observations and ours, but the changes we see from one year to another are so interesting as to give quite a new life to nebulæ observations.

Mr. Huggins: With reference to these changes, if the objects are gaseous, we have no knowledge of their distance.

Mr. Ranyard: It seems probable that the distance of the nebulæ is the same as the distance of the stars which appear to be involved in them. As far as I know there has been no marked

annual parallax observed in any of these stars, and, therefore, the motions which have been described by Mr. Ellery would correspond to velocities far greater than any that we know of at present in the universe.

Mr. Huggins: Yes, that is quite true; but what I meant was, that in former times these nebulæ were thought to be vastly more distant than the stars.

Mr. Ellery then read a paper on *Huygen's Parabolic Pendulum,* for obtaining uniform motion. He said, this is merely a little mechanical arrangement which we have found successful. In the course of some experiments I made about two years ago with the view of obtaining more uniform rotation for the barrel chronograph, I was induced to try Huygens' Parabolic Pendulum, and was surprised that it had not been more generally adopted; at first I thought that there must be some practical difficulty in the application of the principle. I was surprised at the small amount of literature on the subject within my reach, and, therefore, I had nothing to guide me except the bare principle. The earlier results I obtained were so unpromising that my idea that there was some practical difficulty in the way was strengthened, but after trying several tests I satisfied myself that the pendulum would, with moderate precision in its workmanship, become an almost perfect governor for chronographs and well balanced equatorials. In the two chronographs I had constructed for the transit of Venus, and in which I used the parabolic pendulum, the rotation of the drum was practically uniform, and even when there was a variation of the driving weight and a difference of twenty degrees of arc in the position of the revolving pendulum, a straight line could be drawn accurately through the second marks for three hours, in other words, the rotation of the drum was not a tenth of a second out in three hours. As the principle of the Huygenian Parabolic Pendulum may not be known to many of the Fellows of the Society I will illustrate it.

Here Mr. Ellery drew upon the black board. It appeared from his description that Huygen's Pendulum is a form of conical pendulum in which the weight forming the bob of the pendulum is suspended by a piece of very thin spring from the top of a vertical revolving axis, in such a manner that when the rate of revolution of the axis is increased the pendulum flies outwards and unwinds the watch spring from off a piece of metal cut in the form of the evolute of a parabola. In order to prevent the spring twisting or slipping from the surface of the evolute when the rate of revolution of the pendulum is altered, there is a guiding arm which projects from the lower part of the revolving axis and guides the bob of the pendulum.

Mr. Ellery said that he had, in conjunction with one of the American observers of the transit of Venus, tested one of these chronographs by doubling the weight of the bob of the pendulum, and again by halving the weight of the bob, but though the angle which the revolving pendulum made with the axis varied from 10° to 33° yet there was no sensible alteration in the rate. He proceeded: I showed one or two chronograph sheets obtained during these experiments to Sir G. B. Airy and Captain Tupman and others, and I have no doubt they will remember the exceeding precision with which they were marked. It may be said that great precision is unnecessary, and that the ordinary means of obtaining uniform rotation are sufficient for astronomical purposes, but if I agree to that, I still say that this governor is simpler and cheaper than those which aim at only moderate accuracy, and those who have much to do with the reading of chronograph sheets or fillets will find that time is saved when a scale of minutes and seconds can be applied to the register. In an observatory where much transit work is done, any means by which reading off can be facilitated is of great value. I don't imagine there would be any great difficulty in applying these pendulums as governors to equatorials.

Professor Adams expressed the thanks of the Society to Mr. Ellery for his valuable communication.

Professor Pritchard was called upon to read a paper entitled, *Observations on Col. Tennant's experiments on the proper form of a mercurial trough for collimation by reflection of wires.* He said, I have to apologise to the Society for making my observations extemporely, instead of reading a paper. The fact is, I only received the *Monthly Notices* yesterday morning, and what I have to say refers to what is printed there. There are two questions. I find to my great surprise, that Colonel Tennant (for whose astronomical powers we all feel equal respect) has mentioned my name in a very friendly criticism in two papers, and it is to make a very friendly and respectful reply to his observations that I am now about to trouble you upon two practical points. I, many years ago, entered upon a minute and elaborate investigation to see whether it was possible to make mercury behave as a reflecting agent with a little propriety, and not be dancing about in the way that we know that it does, to our great discomfiture. I thought I had succeeded, nay, I am almost sure I succeeded, because in three observatories I have been connected with, I found no difficulty whatever in using mercury as a reflecting agent, whether it be in reflecting wires or observing stars by reflection, we have no difficulty by using this very simple contrivance which I now show you. But Colonel Tennant has met

with a difficulty which I have no doubt every practical astronomer has met with. Colonel Tennant has a very beautiful transit instrument, reversed by certain machinery, which is all the time in contact with the instrument, and he found that Messrs. Cook had supplied him with a cast-iron trough, in which he put his mercury. It was supported by the machinery which reversed the instrument, which machinery was, as I have said, in contact with the instrument, and he says he found he could not get the reflected wires in the telescope at all. I don't think it is likely he could, because the moment he began to fiddle with the micrometer that would move the telescope and away would go the mercury. He says, in a pitiable strain, that this method was simply intolerable, and he had to give it up. The only wonder, I think, is that he ever tried it at all. Then the next step he made is one which everybody else who has had to do with this instrument has made, namely, to remove the support of the mercury from touching the instrument. Then he says Col. Campbell devised a sort of wooden bridge. Well, I have done the same, only mine is an uncouth sort of affair. It is an iron stand that goes over what we use, which is a beautiful altazimuth and 18-inch circle. We put it over the azimuth circle, so as not to touch it, that is what Col. Campbell did, but it failed with him. Well, it was likely to fail, for this reason, as you will see: He says, "I then made a trough of amalgamated copper and a layer of sand." Well, I recommended a layer of sand, and should do so again. This was carried on wooden blocks with a small piece of india-rubber, and he says the time was very favourable for trying it, as there was no traffic, but when there was traffic he did not succeed. Well, there must be something wrong, because with the apparatus which I invented 20 years ago, you certainly may dance about as much as you please in the room, and you won't disturb the perfect reflection of the wires. How then have the mistakes arisen? In order to keep your mercury still, so that the vibrations cease very soon after the disturbing cause, two things are necessary. The first is that the depth of the mercury should be exceedingly small—practically I should say it should not exceed the 30th of an inch, a $\frac{1}{20}$th of an inch will not do, the mercury will not be steady, and there will be a detestable film after a time, and we shall be told the thing fails, but that merely means that you have not provided a means for skimming the surface. I have not measured the depth, but it must be small, not more than the 20th of an inch certainly. This trough is nothing more than a sheet of copper, and upon that I place another sheet about the 30th of an inch thick, and thus you have a rectangular pond, which must be amalgamated with a little care, and then you may knock as

hard as you please and you get no vibration in the mercury, or at all events it will cease in 2 or 3 seconds, and you may go on observing. The scientific explanation of this is that there is a certain amount of adhesion between the molecules of the mercury and the molecules of the copper at the bottom, and the result is that when there is but little mercury above, the vibration that commences stops almost immediately, whereas if you put too much mercury, all the adhesion of the mercury to the bottom will do very little to stop the vibrations. This is what Colonel Tennant did not attend to. If you amalgamate the bottom of the trough, the amalgam will float up to the top of the mercury, and if exposed to the air will oxydize and become very foul indeed. I warn those who use mercury for reflection against this, unless they from time to time skim off the film from the mercury. [The Professor here showed how he procured a good reflecting surface by scraping the surface of the mercury.] Well, now, almost everybody who has touched that has failed, and why? I will give you two little anecdotes. Shortly after this was invented one observatory tried it—it was an important observatory—and they sent to Troughton and Simms to make the apparatus. They produced a contrivance something like a stew-pan, made in a most beautiful way, but it was sent back because it would not amalgamate. I saw it, and I asked why they made it so bright. They said their workmen always finished a thing well. I said, "Did you use oil?" "Yes, a little," they said. "Well," I said, "I didn't undertake to amalgamate oil." Well, there were two mistakes, one was the thing was not copper but oil, and the other was it was five inches deep instead of like this. Now, we have a similar complaint from India. Well, it does not fail with me, nor will it with anybody who does the thing as it is intended to be done. To us it is really a luxury, and we can hardly tell which are the wires and which the reflection. (Laughter.) Really, so useful do we find it, that I am quite sure that no astronomer who will spend a little time about it will fail to obtain similar success. Another observatory got into the same remarkable confusion as the first I have named. And there they made a great discovery, finding that the mercury was not quite still, they dropped a little oil on it to stop the vibrations. It did partially stop the vibrations, but it prevented the amalgamation and affects the brightness. In my method you get success in the simplest possible way, and I commend it to your notice. I will make this remark, that if gentlemen who are now so much better acquainted with physical inquiries than they were, will do me the honour to refer back to 1853, they will find a little paper of mine on the behaviour of mercury with

regard to different metals, and I think they will be really surprised, and might possibly receive a few ideas that they might not have had before. All this pertains to the difficulty Col. Tennant, like everybody else, has had in getting reflections from mercury, and the really ingenious way in which he overcame it. The Astronomer-Royal overcame the difficulty in a way he has recorded, by the use of a rather complex system of vulcanized india-rubber, but I am told it is not absolutely satisfactory. I hope to express in print somewhat more succinctly what I have said, if the Editor of the *Monthly Notices* will allow me.

Mr. Marth: Do you know what is the history of the shallow amalgamated copper trough that you have been describing?

Professor Pritchard: I don't much care what the history of the thing is. I suppose you are going to tell us it was invented by some German.

Mr. Marth: The amalgamated copper trough for the mercury, seems to have been first used by an observer named Schönau, somewhere about the year 1775. [Mistake. It should have been "before 1803."*] But that was not generally known, or it was forgotten. However, after Bohnenberger's method for determining the Nadir had been invented, reflection from the surface of mercury became a matter of greater importance than before, and Schönau's contrivance was remembered and experiments were made about the best form of trough, which led finally to the adoption of the shallow, flat-bottomed trough, first by Steinheil, if I am not mistaken, and then by others.

Professor Pritchard: Well, is that all?

Mr. Marth: Yes, that is all about the copper trough and the shallow mercury, but I should like to know in what else the invention consists?

Professor Pritchard: If you refer to my original paper you will find that I acknowledge the Germans, but before my time it was not known how to scrape the surface of the mercury, and so to obtain a bright surface.

* [Note by Mr. Marth:—Though it is a trifle, some readers will perhaps not object, if I make amends for my indistinct recollection by mentioning now, that it is not the amalgamated copper trough, but the substitution of spider webs for silver wires, and the substitution of ether for spirit of wine in levels, the first knowledge of which is connected with the year 1775. In the miscellaneous notices on page 135 of vol. xii. of the *Astronomische Nachrichten*, published in 1834, Schumacher mentions that Fontana, in Florence, had made both substitutions already before 1775, and he then goes on to speak about the amalgamated mercury trough invented before 1804 by Von Schönau. The dim remembrance of Schumacher's remarks, no doubt, occasioned my mistake.

Schönau was a retired Austrian officer. The description of his contrivance is given, not by himself, but by Canonicus David, in the Berlin *Astronomisches Jahrbuch* for 1807, p. 158.]

Mr. Marth: As a simple matter of fact I may mention, that, when I was a student at Königsberg, a flat-bottomed, shallow trough was used for the Nadir observations, and when the mercury was tarnished the surface was scraped without difficulty to get it clean and bright.*

Professor Adams: There are such things as independent discoveries, and when two or three ingenious people hit upon the same idea, it is the better proof that the contrivance is a good one.

Professor Pritchard: There is nothing new under the sun.

Mr. Ranyard read a paper *On the Duplicate Structure of Coggia's Comet.* He said that, during the early part of July, 1874, the comet was seen to be a twin structure—though there was but one nucleus—there were two sets of parabolic envelopes situated side by side and overlapping, so that the nucleus seemed to be situated at the intersection of the two inner arcs. This structure was drawn by several observers—and there was no doubt about it—but on the 14th of July, the last evening that the comet was visible in England, Mrs. Newall, at Gateshead, and Mr. With, at Hereford, each made drawings which showed two faint parabolic arcs still further in front of the nucleus, and separated laterally by a much greater interval than the former arcs. He thought that this showed that there was a disruptive action going on within the comet as it approached perihelion, which was similar to the disruption which took place in Biela's comet in 1846.

Mr. Ranyard showed a drawing to the meeting by O. Struve, of Biela's comet as it appeared after its disruption in 1846. In the drawing Biela's comet was shown as having broken into two entirely separate bodies, one rather larger than the other; the tails were parallel to each other as in the case of Coggia's comet.

Mr. Ellery: We had Coggia's comet under view, at first for two hours before sunrise, and for about a week it was very brilliant, but we noticed no duplication of the parabolic envelopes. On one occasion there was a suspicion of there being an envelope of this kind, but very close to the inner one. When we last saw the comet it was very far south and like a nebulous star, and the nucleus was almost central to the nebulosity of the comet.

* [Note by Professor Pritchard:—The German contrivance consisted of a *cup-shaped* vessel, in such a form that the mercury is necessarily too deep in the middle, and not at all easy to skim. In my form the depth is uniform and trifling, and admits of skimming with the greatest facility. The Oxford assistants have also told me that the *wind* does not trouble them while using the trough.]

Father Perry showed some photographs of the transit of Venus, taken at Manilla. He said, I have only a very short communication this evening. I have just received some photographs of the transit of Venus from Manilla, ten in number, but, unfortunately, I have not received any details along with them. The photographs are exceedingly well defined, and represent the various phases from the bisection at ingress, with a certain number of pictures of Venus on the sun's disc, and then the remaining six are stages of egress. In No. 7 the planet is apparently exactly at internal contact. I don't think it is quite at contact, but apparently very close indeed, if not actual contact. There is no appearance at all of a "black drop" or anything approaching it; and the only thing is a slight shading which many of the observers have noticed. There is one thing about these photographs which is rather peculiar, which is, that the outer part of the planet in every case shows very distinctly on the chromosphere. Here you have a strong actinic action, and, therefore, the black body of the planet is shown perfectly in the photographs. Of course these photographs are of little value compared with the magnificent series obtained in other places. Clouds interfered with the internal contact at ingress, but I think the observations at egress are well worthy of notice, especially as they bring out some of the most important physical points in the observation of the late transit.

Father Perry further stated that he had prepared a short paper *On the Observations of the November Meteors.* He had, he said, observations taken for a week in November for some years; the observations lasting for an hour or two before the constellation of the Lion rises above the eastern horizon and continued till daybreak. This year there was not a very good chance of observing, particularly the smaller meteors, on account of the light of the moon being nearly full. There were only two good nights, and on one night there was a fair number of meteors from Leo. He thought it right to make this communication, as it might be of value in connection with observations at other places.

Lord Lindsay: On the subject of the first paper, with reference to what Father Perry said about Venus having been seen outside the sun, it seems to me, looking at the photographs, and without being able to measure them, that they have been "touched up." I don't know what instrument was used in taking them, or anything at all about them; but before I attached any great importance to them I should like to see the negatives. I think the fact that Venus is so distinctly visible on the background of sky, outside the sun, is such a very extraordinary phenomenon that it is difficult to credit it, especially when you remember that

you do not see the moon's limb projected upon the chromosphere during a partial eclipse. They are altogether different from any other transit photographs I have seen.

Mr. De la Rue: The diameter of Venus, too, is much too large.

The President: The half of Venus off the sun does not fit the half on the sun.

Lord Lindsay: That is quite understandable from the difference of irradiation. I should be glad to know if Father Perry could tell us what instrument is said to have been used.

Father Perry: I am unable to furnish details at present. I simply received the ten photographs.

Lord Lindsay: It would be interesting if you could get the negatives.

Mr. Brothers: I fancy they must be made from drawings, the "arrow" mark upon them could not be on the negatives. To produce a *black* line as in the prints the arrow must have been scratched on the negatives, if done with ink or black varnish the lines on the prints would have been white. There is evidence also of the texture of the paper from which they have been copied.

Mr. Dunkin said he had a paper by Mr. Marth on the positions of the satellites of Uranus. It gave the positions of the satellites for every five days from January 1st to April 30th. If it had not been for the work of Mr. Marth with regard to Saturn, no observations would have been made of the satellites, at the opposition, but in consequence of his calculations a series of observations had been made both at Greenwich and Oxford, and astronomers ought to be thankful that they had in the Society a computer willing and able to devote his time to this matter. (Hear, hear.)

Mr. Dunkin drew attention to the fact that among the papers was a description of the manuscripts left by the late Professor Rigaud. Another valuable paper was on the measurements of the ring nebula in Lyra, by Professor Holden, of the United States observatory. These papers would appear in the *Monthly Notices.*

Mr. Ranyard said, I should like before the meeting breaks up to read a part of Mr. With's paper on the structure of Coggia's comet. On the night of the 8th July, 1874, he observed a remarkable oscillatory motion of the fan-shaped jet upon the nucleus as a centre, which occurred at intervals of from 3 to 8 seconds. The fan seemed to "tilt over" from the preceding to the following side, and then appeared sharply defined and fibrous in structure, then it became nebulous, and all appearance of structure vanished. Such appearances have been observed by

other people in comets, though I do not know whether in Coggia's comet. There seems to be no doubt about the pulsations, whatever may be the cause of them.

The meeting closed at about ten o'clock. The following papers were taken as read:—

Note on a new variable star in Capricornus: by Mr. J. E. Gore.

On the double star 61 *Geminorum*: by the Rev. S. J. Johnson.

On some old Pictures of Saturn: by Mr. C. L. Prince.

On a new form of observing chair: by Mr. Wentworth Erck.

On the Oxford ephemeris of twelve close circumpolar stars for 1875: by Professor Pritchard.

REVIEWS.

Transit of Venus, &c. By Richard A. Proctor. Second edition, with an account of the successes achieved in December, 1874, and suggestions respecting the Transit of 1882. Longmans, 1875.

"The sale of 1,500 copies of the present work in six months shows that many besides astronomers have taken interest in the efforts made during the recent transit to improve our knowledge of the dimensions of the solar system. In the present edition I have given a general account of the successes achieved last December. I have also devoted special attention to the advantages which may attend the use of the mid-transit method in 1882." (Extract from preface).

We scarcely expected that a new edition of this valuable work would have been so soon required; and we think with its author, that the welcome extended to it may be taken as evidence of a remarkable increase during the last few years of interest in scientific subjects. For those who have not seen the first edition, we may state that the volume contains five chapters: I. Transits of the seventeenth century; II. Transit of 1761; III. Transit of 1769; IV. Transits and their conditions; V. Transits of 1874 and 1882. There are six tables, twenty plates, and forty-four woodcuts; praise of all which is now superfluous.

Victoria. Tenth Report of the Board of Visitors to the Observatory, with the Annual Report of the Acting Government Astronomer for the year ended 29th May, 1875. Melbourne.

Mr. White is acting for Mr. Ellery during his absence in Europe. Instruments and buildings generally are in good order. The former have been increased during the year under notice by a capital photo-heliograph by Dallmeyer, constructed under the advice of Warren De la Rue, Esq., an equatorial refractor of 8-in. aperture by Troughton and Simms, under the advice of Sir George Airy, besides other minor instruments. The great Melbourne Telescope has been confined as much as possible to its specific work. One photogram of the moon, in the opinion of the Board, surpasses in beauty of outline and in accuracy of definition any hitherto taken in the world. The best mode of lithographing the nebulæ is still under consideration, and awaits Mr. Ellery's return. This fine reflector has been diligently worked, principally in drawings of the nebulæ, and mapping of the neighbouring stars; "ten of the nebulæ and clusters,

figured by Sir John Herschel, have been carefully drawn, and the positions of the stars laid down by micrometer measurements. One nebula has been observed which is not to be found in any catalogue in our possession. Coggia's comet was examined on 18 nights, and 15 drawings of it obtained. A drawing of the nebula surrounding η Argus, with the stars accurately plotted in, made this year, shows no appreciable change when compared with the one made last year."

Might not observations on the three outer planets and their satellites be sometimes made to great advantage by means of this powerful instrument? We rejoice in the well-directed activity that characterises this important observatory. Besides the observations of the transit of Venus, which entailed much extra work, the first Melbourne catalogue of 1227 stars for the epoch of 1870, was published in time to be used with great advantage in the observations by the different parties of the transit of Venus. The observations in meteorology, terrestrial magnetism, &c., have been published down to December, 1874. The time signals for the shipping are continued. The staff of the observatory under Mr. White consists of Mr. Moerlin, Mr. Turner, Mr. Gilbert, and Mr. Hay on probation. The last mentioned young gentleman was placed by the Chief Secretary to assist in the increasing work of the observatory in November, 1874, and "has proved himself, by his punctuality and diligence, to be a very valuable aid in the routine duties of the establishment." An unremitting application of 22 years to the duties of his office had greatly impaired the health of Mr. Ellery, and Mr. White concludes his report by expressing the hope that at the next annual inspection, he will have returned from his visit to Europe, with renewed health and vigour, to superintend the work over which he has so long and so ably presided. In this hope, in common with many, we cordially unite.

Auxiliary Tables for determining the angle of position of the sun's axis, and the latitude and longitude of the earth referred to the sun's equator. By Warren De la Rue, D.C.L., F.R.S.; V.P.R.A.S., &c. pp. 20. London: Taylor and Francis. 1875.

"These tables, which have been computed by Mr. Marth, are employed in the reduction of the ten-year series of solar photograms taken at Kew. As they are of general application in the reduction of observations of the sun, I have thought that they would be acceptable to astronomers, and have had some copies printed for private circulation." Astronomers will be much obliged to Dr. De la Rue for furnishing them with these very useful tables.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Permit me to add to my remarks on the nebulæ η Argus and 30 (Bode) Doradûs, reported by you, one or two additional particulars.

The instrument used by me in making the drawings differs less from Sir J. Herschel's 18-in. metal mirror, as regards light and grasping power, than Mr. Ellery's 48-in. does, 12 inches of silver being probably equivalent

to 15 inches of speculum metal as far as the quality in question is concerned.

The enormous illuminating power at Mr. Ellery's command would of itself give the impression of extensive changes in objects of such complexity as those which he described, by revealing details faintly or not at all visible to the smaller instrument employed by Sir John 40 years before.

It will suffice to quote a parallel instance of total transformation of the appearance of a nebula by bringing to bear on it an instrument far exceeding in light-grasp those previously employed; namely, the case of the well-known nebula in *Canis Venatici*, formerly known as a bright double nebula, but now recognised with a well-marked spiral since the application of the 6-ft. mirror at Parsonstown.

My objects in bringing the matter forward at the meeting were to state my own impression that there had been *decided* change in both the nebulæ, not *radical* change, which Mr. Abbott some years since considered to have been the case with respect to the Argus nebula; and secondly, my wish was to obtain better information on the subject, from some more competent observers who might possess more extensive opportunities than I had myself enjoyed. All who heard his remarks will agree with me that the second of these objects could not have been more perfectly attained than by the courtesy of Mr. Ellery.

I am, Sir, yours truly,
C. E. BURTON,
Formerly of the Observatory, Parsonstown.

ESTIMATION OF STAR MAGNITUDES.

Sir,—The amateur astronomer who commences anything like systematic observations on the fixed stars, will find himself confronted by a difficulty which really involves points of such moment that it is surprising that so few attempts have ever been made to grapple with it. I am alluding to the estimation of star magnitudes, sometimes, rather pompously, talked about as "Stellar Photometry." The vagueness of language in use respecting star magnitudes is as surprising as it is unsatisfactory, and when one considers the precision which characterises modern science, one is astonished that so little has been done to remove it. I do not think it too much to say that *estimates of star magnitudes not based on methodical experiment are rarely trustworthy;* and this often applies even to statements made by experienced observers.

To Dawes is mainly due the credit of initiating a genuine reform as to this matter. *The principle* of his suggestion is to diminish the light of the stars examined so as to reduce them to some common standard of brightness. This is done (1) by diminishing the aperture of the telescope employed till the star under comparison becomes barely but steadily visible; and (2) to take as the standard aperture that which just secures visibility to the average of several of Argelander's stars of the 6th magnitude. "Assuming, then, the obvious principle that if two stars, as viewed through a telescope, appear equally bright, the illuminating powers employed (that is, the areas of the portions of the object glass employed) must be inversely proportional to their magnitude or real brightness, it is easy to calculate the areas of the portions that must be left exposed to render *just* visible the stars arranged according to a definite scale of magnitudes," and to provide by means of the

formula given a series of pasteboard rings that can be readily numbered and applied to any particular telescope. To put this idea into practice the first thing that an observer must do is to determine experimentally for himself what is the aperture of the telescope he uses which will give the desired visibility to average stars of the 6th magnitude, and from that to determine the apertures corresponding to smaller magnitudes. Of course in obtaining the standard of aperture for an average 6th magnitude star (on which the other apertures depend) reliance must not be placed on one star only; at least a dozen should be made use of.

In working out this matter Dawes stated that he had intended to adopt Sir J. Herschel's scale, as generally avoiding the use of half-magnitudes, but that eventually he decided to conform to Struve's ratio of progression in order that his results might be comparable with those obtained by such leading observers as La Lande, Piazzi, Bessel and Argelander.

Putting m = the standard magnitude; a the aperture necessary to show it; μ = any other inferior magnitude, and x = the aperture necessary to render visible a star of magnitude μ, we shall obtain the equation:—

$$x = a \times 2^{\mu - m}$$

Of course one and the same power must be used invariably in operating with a series of apertures thus obtained.

When the apertures corresponding to each magnitude and half-magnitude have been thus ascertained by calculation, a series of discs must be prepared and pierced as may be requisite. Many persons will be able to do what is necessary themselves, but if not, the assistance of an instrument maker must be sought.*

I have been led to deal with this matter because Dawes's papers are, I fancy, little known, being buried in old volumes of the *Monthly Notices*, and because I deem them of considerable value. Perhaps the publication of these remarks may draw forth from some of your readers practical criticisms on the working out of Dawes's idea, as to precautions to be adopted, and otherwise evoke useful suggestions.

Your obedient servant,

Northfield, Eastbourne: G. F. CHAMBERS.

Nov. 29, 1875.

NOTES ON STARS POSSIBLY VARIABLE.

Sir,—A correspondent of mine (who is also a correspondent of yours, I believe), Mr. J. E. Gore, of Umballa in the Punjaub, has sent me some notes, which I think I ought not to keep for my private use exclusively. I beg, therefore, to submit them to you for publication, conceiving myself justified in doing so.

Eastbourne: Your obedient servant,

Nov. 27, 1875. G. F. CHAMBERS.

27 Canis Majoris, R.A., 7h. 9m. 22s., Decl. S. 26° 8′ 58″ (1880). Near δ. This star was rated 4 m. by Harding, 5½ by Lacaille, 5 m. by Argelander, 6·5 by Heis, 6 m. by Behrman, and 7 m. by Flamsteed. In 1874 and

* See *Monthly Notices*, Vol. xi. p. 187, June, 1851: Vol. xii. p. 80, February, 1852: Vol. xiii. p. 277, 1853.

1875 I found it about $5\frac{1}{2}$ or 6 m., and much inferior to No. 28, which Harding shows as 5 m. It is probably variable from $4\frac{1}{2}$ to $6\frac{1}{2}$ m., with a long period.

43 (*d*) Sagittarii. R. A., 19h. 10m. 37s., Decl. S. 19° 25′ 18″ (1880). Near ρ^1 and ρ^2. This star was rated 4 m. by Harding, and 6 m., 8 m. by Lalande. Argelander estimated it at 5 m. It is at present about $5\frac{1}{2}$ m., being brighter than ρ^1 Capricorni (5 m.), but brighter than ρ^2 (6 m.). It is possibly variable from $4\frac{1}{2}$ to 6 m.

Herschel's "fine ruby star" in Capricornus. R. A. 20h. 10m., Decl. S. 21° 41′. Closely n. p. 4 Capricorni (6 m.). This star which is No. 251 in Catalogue of Red Stars, *Descriptive Astronomy*, p. 591, was rated by Herschel at $6\frac{1}{2}$ m. It is 7 m. in Harding, and $7\frac{1}{2}$ m. in Lalande's catalogue. Last month I found this star to be only $8\frac{1}{2}$ or 9 m., and fiery red. It is quite invisible to the naked eye, or even in an opera glass. If Herschel's estimate of $6\frac{1}{2}$ m. was correct, the star must certainly be variable to the extent of two magnitudes. I propose to call the star V Capricorni.

J. E. GORE.

LUNAR NOMENCLATURE.

Sir,—In Mr. Neison's Catalogue of Points of the First Order on the moon's surface, recorded in the *Monthly Notices* of the Royal Astronomical Society, vol. xxxvi.. p. 20, he suggests the name "Wichmann" for the spot Euclides *a*. Probably Mr. Neison selected the name for this spot on account of the name "Kaiser" having been suggested for Mösting A, in the November number, p. 257. Upon finding that Wichmann had conducted so elaborate an investigation on Mösting A, I suggested, in the *English Mechanic*, Dec. 10, 1875, that Mösting A should bear the name of "Wichmann." In order that Wichmann's name should be appropriated to his own spot, I would suggest, if agreeable to Mr. Neison, that the names should be interchanged, Mösting A bearing that of "Wichmann," and Enclides *a* that of "Kaiser." Mr. Neison has designated Fracastorius E as "Rosse." As there is another Rosse in the S.E. quadrant, would it not be better to append the Roman numeral II., as in the case of the two Herschels ?

Dec. 15, 1875. I am, Sir, your obedient servant,

W. R. BIRT.

FINE METEOR.

Sir,—Whilst observing Mercury this morning, I was startled by the appearance of a very vivid meteor, emanating from some point in Leo, which shot down to the S.E. horizon and disappeared not far from Spica. The time was about 6.30 a.m. The meteor was of a reddish colour and quite lit up that portion of the sky for the moment, in spite of the glare of the moon. I was surprised with the brilliancy of Mercury to the naked eye. It seemed to be more conspicuous than Spica, although seen upon a much brighter background of twilight.

I am, yours truly,

1, High Street, Leicester: W. S. FRANKS.
November 15, 1875.

DISCOVERY OF MINOR PLANETS (156, 157).

(From *Astronomische Nachrichten*, No. 2,067.)
Telegraphic despatch from Professor FOERSTER to the Editor.
Planet Palisa, 22 Nov. 12h. om. Pola $\alpha = 43° \ 35'$, $P = 70° \ 23'$.
Motion Southerly. Mag. 12.
Berlin: November 23, 1875.

(From Supplement to *Astronomische Nachrichten*, No. 2,067).
Planet (157), discovered by Borelly, at Marseilles.
1875, Dec. 1. $\alpha = 4h. \ 22m.$ $\delta = +23° \ 58'$. Magnitude 13.
Berlin: December 3, 1875.

EPHEMERIS OF THE SATELLITES OF URANUS.

At Greenwich Midnight.

	Ariel.		Umbriel.		Titania.		Oberon.	
1876.	pos. °	dist. ″	pos. °	dist. ″	pos. °	dist. ″	pos. °	dist. ″
Jan. 1	22	14	21	19	182	33	26	39
2	241	9	331	13	156	23	12	45
3	124	7	204	18	81	16	0	44
4	348	12	147	14	30	28	345	35
5	188	15	28	17	9	34	315	23
6	25	13	343	16	347	27	258	22
7	240	8	213	16	294	16	220	32
8	134	8	167	17	222	23	202	42
9	352	13	48	15	195	34	189	46
10	190	15	351	18	175	31	176	42
11	29	13	224	14	140	19	158	32
12	249	7	175	19	60	19	121	22
13	142	9	50	13	23	31	66	24
14	355	13	358	20	4	34	34	35
15	193	15	239	11	337	24	18	44
16	33	12	181	16	267	16	5	46
17	261	7	70	10	212	27	353	40
18	150	9	5	21	189	34	331	29
19	358	14	261	10	169	28	286	21
20	195	15	187	21	118	16	234	27
21	38	11	95	10	44	23	209	38
22	273	7	9	21	17	34	194	46
23	155	10	289	10	357	32	182	45
24	0	15	193	21	323	20	168	38
25	203	15	122	10	244	18	141	26
26	43	10	16	21	204	31	90	21
27	286	7	313	11	184	34	46	30
28	162	11	199	20	159	25	25	41
29	3	15	143	12	92	16	11	46
30	201	14	22	19	34	27	359	44
31	49	9	330	13	11	35	342	35

A. MARTH.

ASTRONOMICAL OCCURRENCES FOR JANUARY, 1876.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. α Orionis
Sat	1		Sidereal Time at Mean Noon, 18h. 41m. 58·11s.			11 4·7
Sun	2	8 —	Sun's Meridian Passage 4m. 6·92s. after Mean Noon Conjunction of Moon and Mars 0° 55′ N.			11 0·7
Mon	3	9 10 10 5	Occultation of B.A.C. 57 (6½) Reappearance of ditto			10 56·8
Tues	4	3 23 5 4	☽ Moon's First Quarter Near approach of B.A.C. 274 (6)	1st Sh. I. 2nd Tr. I. 1st Tr. I.	17 59 18 39 18 55	10 52·9
Wed	5			1st Oc. R.	18 21	10 48·9
Thur	6					10 45·0
Fri	7	6 39 7 13 7 36 8 24 8 5	Near approach of 23 Tauri (5) Near approach of η Tauri (3) Occultation of 27 Tauri (4) Reappearance of ditto Near approach of 28 Tauri (5½)			10 41·1
Sat	8					10 37·2
Sun	9	3 37 4 26	Occultation of 136 Tauri (5) Reappearance of ditto			10 33·2
Mon	10	18 23 6 59 7 59	○ Full Moon Occultation of 47 Geminorum (6) Reappearance of ditto			10 29·3
Tues	11	19 18 20 7	Occultation of γ Cancri (4½) Reappearance of ditto	2nd Sh. I. 1st Sh. I.	19 24 19 52	10 25·4
Wed	12			1st Ec. D.	17 8 10	10 21·4
Thur	13			1st Tr. E. 3rd Tr. I. 2nd Oc. R.	17 35 18 14 18 40	10 17·5
Fri	14					10 13·6
Sat	15		Illuminated portion of disc of Venus=0·888 Illuminated portion of disc of Mars=0·896 Sidereal Time at Mean Noon 19h. 37m. 9·93s.			10 9·6

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m.
Sun	16	12 6 12 40 20	Occultation of B.A.C. 4294 ($6\frac{1}{2}$) Reappearance of ditto Conjunction of Saturn and Venus 0° 21′ S. Saturn's Ring: Major axis=35″·19 Minor axis=7″·3			10 5·7
Mon	17	20 49	☾ Moon's Last Quarter			10 1·8
Tues	18		Sun's Meridian Passage 10m. 33·76s. after Mean Noon			9 57·8
Wed	19			1st Ec. D.	19 1 41	9 53·9
Thur	20	17 12 19 2 20 24 11	Occultation reappearance of B.A.C. 5314 (6) Occultation of B.A.C. 5347 (5) Reappearance of ditto Conjunction of Moon and Jupiter, 5° 22′ N.	2nd Ec. D. 1st Tr. I. 3rd Sh. I. 1st Sh. E.	16 39 48 17 20 17 57 18 25	9 49·9
Fri	21			1st Oc. R.	16 47	9 46·0
Sat	22			2nd Tr. E.	16 3	9 42·1
Sun	23					9 38·2
Mon	24					9 34·2
Tues	25					9 30·3
Wed	26	1 41	● New Moon			9 29·4
Thur	27	14 15	Conjunction of Moon and Mercury 3° 10′ N. Conjunction of Moon and Saturn 1° 41′ N.	1st Sh. I. 2nd Ec. D. 1st Tr. I.	18 6 19 12 35 19 16	9 22·4
Fri	28	9 17	Conjunction of Moon and Mercury 1° 38′ N. Conjunction of Moon and Venus 0° 26′ N.	1st Ec. D. 1st Oc. R.	15 23 38 18 44	9 18·5
Sat	29			2nd Tr. I. 2nd Sh. E. 2rd Tr. E.	16 12 16 26 18 45	9 14·6
Sun	30					9 10·6
Mon	31	4	Conjunction of Moon and Mars 1° 10′ S.	3rd Oc. D. 3rd Oc. R.	16 56 18 41	9 6·7
FEB.						
Tues	1	5 58 6 59	Occultation of π Piscium (6) Reappearance of ditto			9 2·8

THE PLANETS FOR JANUARY.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	19 2 20	S. 24 41	4″·8	0 20·3
	9th	19 59 30	S. 22 46½	5″·0	0 45·8
	17th	20 54 34	S. 19 12	5″·4	1 9·4
	25th	21 41 33	S. 14 24½	6″·4	1 24·7
Venus ...	1st	20 31 46	S. 20 35	11″·2	1 49·5
	9th	21 12 25	S. 17 55	11″·4	1 58·6
	17th	21 51 36	S. 14 43	11″·6	2 6·2
	25th	22 29 24	S. 11 6	12″·0	2 12·4
Mars ...	1st	23 21 1	S. 4 52	7″·6	4 38·3
	9th	23 42 1	S. 2 26½	7″·4	4 27·8
	17th	0 2 54	S. 0 1	7″·0	4 17·1
	25th	0 23 46	N. 2 23	6″·8	4 6·5
Jupiter ...	11th	15 35 34	S. 18 21	31″·4	20 10·9
	17th	15 39 32	S. 18 34	31″·8	19 51·2
	25th	15 44 25	S. 18 49½	32″·4	19 24·6
Uranus ...	1st	9 28 18	N. 15 42	4″·2	14 43·9
	17th	9 26 3	N. 15 53	4″·2	13 38·8
Neptune ...	1st	1 55 14	N. 9 54½		7 12·1
	17th	1 55 11	N. 9 55		6 9·1

Mercury sets a few minutes after sunset, at the beginning of the month, the interval increasing to an hour and three quarters on the 31st.

Venus sets two hours after the sun on the 1st, the interval gradually increasing.

Mars may be observed for 6 hours after sunset during the whole month.

Jupiter rises nearly four hours before the sun at the beginning of the month, the interval slightly increasing.

Uranus is well situated for observation.

LUNAR OBJECTS SUITABLE FOR OBSERVATION IN JANUARY, 1876.

By W. R. Birt, F.R.A.S., F.M.S.

In the interval that has elapsed between July, 1873, and the present month, attention has been directed to the *named* objects in each of the Zones of the British Association Map, the number of the *Astronomical Register* for July, 1873, containing Zone I. 0° to 5° N. latitude. In order to avoid repetition these objects may be sufficiently indicated in this communication by their numbers in Webb's Index Map (*a*), as follows:—511† (*b*), 10, 326, 488, 67 (*c*), 65, 64, 487, 455, 456, 486, 99, 445. 443, 444, 102, 103, 104, 94, 501 (*d*), 512, 105, 106* (*e*), 513*, 113, 515* (*f*), 500† (*g*), 114, 505† (*h*), 502† (*i*), 143, 154, 153 and 155.

This Zone contains the following points of the *First* Order.—The letter B prefixed signifies that it occurs in B. and M's. list; N, that it has been re-determined or newly determined by Neison, see *Monthly Notices*, R.A.S., vol. XXXVI. pp. 19 and 20.

			°	′	″		°	′	″	
W. longitude	B.	Schubert A.	77	15	51	...	2	27	42	N. lat.
,,	B.	Maskelyne	29	34	58	...	2	31	38	,,
,,	B.	Dionysius	17	8	40	...	2	50	55	,,
,,	B.	Agrippa	10	22	13	...	4	4	16	,,
,,	N.	,,	10	4	17	...	3	55	20	,,
,,	N.	Hutton (*d*)	1	0	4	...	4	3	57	,,
E. longitude	B.	Gambart A	18	45	12	...	0	50	30	,,
,,	N.	Reinhold	22	37	26	...	3	13	19	,,
,,	N.	Beke (*h*)	31	5	26	...	0	2	20	,,
,,	N.	Hunter (*i*)	36	18	56	...	1	57	6	,,
,,	N.	Encke	36	35	35	...	4	18	14	,,

B. and M's. points of the first order will be found in the Report of the British Association for the Advancement of Science, 1866, pp. 220—222.

Notes (*a*).—For additions since the publication of the map see the *Register* for December, 1875, p. 257, those which have been newly added in revising this Zone have numbers above 499 (Zollner)—see list for November, 1875, on p. 273 of the *Register* of that month. An asterisk (*) appended to numbers in this Zone signifies that the name has been restored to the original object, and a dagger (†) that the name is newly added.

(*b*) Key. Observations of this depression of flattening are very important in order to determine if the flattening observed by Mr. Key be the *lowest* portion of the Mare Smythii, or a depression *further* west than it; the positions of the Mare and the flattening agree in latitude.

(*c*). In this Zone between 30° and 35° of west longitude, according to B. and M., a group of anonymous objects exists. These objects are situated to the W.S.W. of Maskelyne, and from the head-land jutting into the Mare Fœcunditatis; this head-land is distinguished by a twin crater nearly due north of Censorinus; the eastern of the two craters is marked *c* by B. and M. On the thirty-fifth meridian west, B. and M. gives a ring *f*. As these objects are given on the authority of B. and M. only, perhaps observers will kindly examine this region previous to designating either the twin crater or the ring by proper names.

(*d*). Triesnecker or Murchison A, (see *Astronomical Register*, November, 1875, p. 270) having been constituted a point of the First Order, in order to avoid ambiguity it is proposed to designate it Hutton (501), in commemoration of the Mathematician of that name.

(*e*). Dantes Montes. This name Dantes according to Lambert, who places it in 10° E. longitude and 2° N. latitude, was given by Riccioli. It appears in Lambert's Table of the longitudes and latitudes of 207 Lunar Spots in Brewster's Supplement to Ferguson's Astronomy, vol. II. p. 163. B. and M. have at the point indicated by Lambert a mountain 475 toises high, their ε of the Sömmering range; it is this range for which the name of Dantes Montes is proposed; there are two other peaks on this range further S.W. than E., namely δ 432 and β about 350 toises. I have not the map of Riccioli to refer to just now, and, therefore, cannot say in what form he represented the objects, but the R.A.S. possesses a copy.

(*f*). Rhæticus *pre*. This is one of the three dark spots seen at the time of Full Moon, which B. and M. failed to find. They were named Lacus Herculeus by Hevelius. Of these the north-west was named by Riccioli "Dominicus Maria," the south-west "Stadius," and the east "Rhæticus." Webb says of these spots "B. and M. puzzled in identification, owing probably to their being *full moon* markings (though easy ones), dealt summarily with this nomenclature—ignoring Dom

Maria * * * transferring Stadius across it * * * and removing Rhæticus to 104 at some distance." In restoring Riccioli's nomenclature it is necessary to affix the word "*pre*," as signifying the original spots to which the name was applied DOM MARIA 514 is in Zone III. STADIUS *pre* is numbered 513 and RHÆTICUS *pre* 515.

(*g*). 500†. This crater on the north-west of Reinhold is very conspicuous and interesting, and as such entitled to a proper name. The name proposed for it is TENNANT, as commemorative of the Eclipse labours of Colonel Tennant. Drawings of Reinhold, Tennant, and the surrounding region will be acceptable to compare with those in our possession.

(*h*). A point of the *First* Order (Neison), Landsberg A proposed name BEKE, commemorative of the Traveller of that name.

(*i*). A point of the *First* Order (Neison), Encke B. Name proposed HUNTER, commemorative of the Founder of the Museum of the College of Surgeons.

It is recommended to observers to examine the Zone in the order in which the numbers are arranged. That portion of the Zone between 20° west longitude and the First Meridian is especially described in "Catalogue of Lunar Objects, areas I. A. α, I. A. β, I. A. γ, I. A. δ, forming part of "Contributions to Selenography."

Books Received.—Mr. De la Rue's "Tables for determining the position of the sun's axis." London: Taylor and Francis. 1875.—"The Origin of the Stars." By Jacob Ennis. London: Trübner and Co.—"Tenth Report of the Board of Visitors to the Observatory at Victoria." Melbourne, 1875. G. Skinner.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To Sept., 1875.
London Institution.

To Dec., 1875.
Bridson, W. J.
Elliott, R.

To Jan., 1876.
Shaw, Rev. J.

To March, 1876.
Barber, R. W.
Franks, G. R.
Lewis, H. K.
Rivaz, Miss.

To June, 1876.
Brothers, A.
Main, Rev. R.

To Dec., 1876.
Baldelli, Contessa.
Birt, W. R.
Garnett, W.
Johnson, R. C.
Johnson, Rev. S. J.
Jones, Rev. E.
Joynson, J.
Knott, G.
Ledger, Rev. E.
Lee, J.
Rogers, W.
Rogerson, G. R.
Walker, G. J.

To Oct. 1877.
Bookwalter, F. M.

TO CORRESPONDENTS.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to JOHN C. JACKSON, at Lower Clapton, London, E.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications, Letters, Articles for insertion, &c., must be sent to the Rev. J. C. JACKSON, *Clarence Road, Clapton, E.*, **not later than the 15th of the Month.**

The Astronomical Register.

No. 158. FEBRUARY. 1876.

ROYAL ASTRONOMICAL SOCIETY.

Session 1875—76.

Last Meeting of the Session, January 14th, 1876.

Professor Adams, F.R.S., *President,* in the Chair.

Secretaries—Mr. Dunkin and Mr. Ranyard.

The minutes of the last meeting were read and confirmed.

Forty presents were announced as having been received since the last meeting, and the thanks of the Society were voted to the donors.

The following candidates for the fellowship of the Society were balloted for and duly elected:

Prof. Cleveland Abbe, Washington.
William Barnsby, Esq., Saltmarsh Castle, Herefordshire.
Rev. H. Collins, Vicar of Ellerton, near Whildrake, York.
Augustus S. Harrison, Esq., Muir College, Allahabad.
R. Coward Johnson, Esq., Warrenside, Blundellsands, near Liverpool.
J. Young Messum, Esq., Controller of Packet Services, General Post Office.
H. C. L. Saunders, Esq., Leacroft House, Staines.
Major W. H. Wardell, R.A., 3, Alexandra Terrace, Sheerness.

Mr. Dunkin read a paper by the Astronomer-Royal. *On the present state of the calculations for his new lunar theory.* The paper referred to the two preceding communications to the Society, printed in the *Monthly Notices* for January, 1874, and March, 1875, in which the plan of his new method was explained, and then described the present state of the calculations.

Mr. Dunkin: The object of the Astronomer-Royal in making these reports is principally that the public may know exactly in what state the calculations are. It is a very enormous work, and if any unexpected calamity should happen, the Astronomer-Royal is anxious that the public should know the exact condition in which his work has been left. It was a great misfortune when M. Delaunay was taken away that no one knew the exact state of his lunar theory, and nobody knows now, I believe, how M. Delaunay's work was left.

The President: These reports are certainly very important.

Capt. Orde Browne read a paper *On the times of the phenomena of the transit of Venus.* He compared the times of the observations at the various Egyptian stations. He concluded from the reports he had seen that the phases of contact might be divided into three classes: 1st, Shadow contacts, including those where the connection between the limbs of Venus and the Sun was observed to be decidedly less dark than the body of the planet. Sometimes it was spoken of as a faint shadow, and sometimes as an interference line; 2nd, There was black contact, in which the ligament appeared to be solid, and as dark, or nearly as dark, as the body of the planet; and 3rd, There was geometrical contact, in which the observer waited until he judged that the limb had a common tangent with the sun's limb. The paper detailed the instances in which the times of one or more of these phenomena had been noted by one and the same observer, and gave their estimates of the time that had elapsed during the different phases. If it were allowable after the transit to test personal equations by the "model" (which he did not admit), then there was a singular agreement as to the results as to the black contact phase, showing apparently that that which all the observers saw was a definite thing that admitted of being recorded. With regard to the interpretation of the records, he thought that the model at Greenwich would generally represent the phases, as the observers recorded them, and could be set to represent, as nearly as possible, the phase which had been noted by the observer, although in some instances it would not represent the phase seen, so the observers asserted. With reference to the double-image micrometer measures, they were not finished yet, and it would be premature to give them, but they are coming out better than was

expected. The latitudes of the places affecting the observations have come out very closely.

Mr. Burton said: As to the visibility of the planet outside the Sun before ingress, at my station it was distinctly seen with a 2-inch telescope and power of 30, for about fifteen minutes before internal contact; and with reference to the phases of the planet and model, the former markedly excel the phases of the photographs in all cases; evidently the limb of the planet is affected by some cause external to the instrument.

Mr. Nichol: I examined the planet very carefully as she was going on to the Sun, and the chief difficulty I had was owing to the rim of light outside the planet. After I had measured the cusps with the micrometer, and when I thought that geometrical contact was about to take place I inserted the eye-piece, but found that as soon as I had focussed the eye-piece the light was continuous between the cusps of the sun and the planet. The reason why I changed the eye-piece at the time was that I thought the cusps of the planet were approaching one another more rapidly than I expected from my previous model practice. When I changed it, I was of course thunderstruck to see that the cusps were met. The question I put to myself at the time was, "Is that sun-light, or is it not?" and the conclusion I came to was that I could not tell; it appeared to be so bright that it was utterly impossible to tell whether it was sun-light or merely the bright rim round the planet grown brighter. The next thing was to look out for the peculiar ligament phases, but I could not see any. The only phase that I could have noted, and that was a matter of guesswork, was the particular time at which the line round the planet got broader: one might have notified this phase, but the broadening was such a long time in taking place that it was impossible to record any observation whatever.

Mr. Ranyard: Did Mr. Burton say he saw the whole of the planet fifteen minutes before external contact?

Mr. Burton: Before internal contact at ingress—that is to say, at the time of bisection on the sun's limb I saw the half of the planet.

Mr. Ranyard: Then you saw the whole of the external half?

Mr. Burton: Yes.

Mr. Ranyard: Was there a bright line round it?

Mr. Burton: I could not tell whether it was due to the bright line, or the brightness of the sun's corona.

Lord Lindsay: I understood that none of the times of the observations of the transit should be published until all the times could be given by all the observers, both here as well as in Germany, Russia, and America.

Captain Orde Browne: The only thing to be said in reply to Lord Lindsay's remark is, that the times I have given were nearly all published here in England twenty-four hours after the transit. The only point I have tried to call attention to is that the difference between the different recorded times, which is sometimes very considerable, is to be accounted for by supposing that different phases were observed, in fact, that there exists a symmetrical sort of difference between the times.

The President: I understand Captain Orde Browne to say there were three distinct phases and that one or other of these was the one observed by each observer—some observing one and some another, and some more than one; but am I right in supposing him to say that the descriptions generally given by the different observers were sufficient to decide which of these phases any particular observation referred to? Is it merely a matter of *a posteriori* deduction, that a certain phase is interpreted to be a distinct one of these three, because the time given agrees with what should be the time, or is it to be understood that the descriptions of the different phases given by the observers are sufficient to identify the phases?

Captain Orde Browne said: Where any doubt exists, the actual words used had been given in his paper. Admiral Ommanney's observations had been noted as geometrical contact, but in the case of the Melbourne observations the three several phases were recorded. In some cases the words used were "geometrical contact;" in others, "a shadowy ligament" is spoken of; and in such cases there could be no doubt about the meaning. In many cases only one observation was recorded by each observer, but some observed two, and the observations were of value when two or more were recorded, because it gave the opportunity of learning and comparing the differences of time between phases. It would be remarked that in most cases it was lady observers who had recorded more than one observation (laughter); at Suez Mr. Hunter recorded two or three.

Mr. Dunkin said: With respect to the publication of the times, it must be remembered that the Egyptian times were published in the *Monthly Notices* in a paper by Admiral Ommanney and the times at Mokattam we published in the last annual report, so Captain Orde Browne was not publishing anything that was not already known, yet he (Mr. Dunkin) quite agreed with Lord Lindsay that it was an improper thing that the times should be published, because it was possible that some people might make an improper use of them, that is to say, they might cook their own observations to make them agree with those already published. (Laughter.)

Lord Lindsay explained that he had mentioned the matter because the agreement to keep the observations secret had been very widely discussed abroad, but it was his fault, not having known before that the figures had already been published.

Mr. Christie read a description of a new form of solar eye-piece. He said there was only a slight novelty in the principle that he desired to call the attention of the Society to. The chief point was that in place of putting the reflecting surfaces, as ordinarily used for diminishing the sun's light, in front of the field lens, he thought it would be desirable to place them between the eye-piece and the eye, and by that means smaller surfaces could be used, and the eye-piece could be brought into a more compact form. He had applied the principle in two forms. In the first form he used a Nicol's prism. The only difficulty with this eye-piece was that you could not get a sufficiently large field, but this was perhaps a matter of no importance in the case of the sun. If the Nicol's prism was taken away, a field of 20′ could be obtained, but with the Nicol's prism a field of only something like 10′. The second form he had tried was a similar application to the ordinary polarizing eye-piece. This also could be applied to any eye-piece. The usual difficulty was that they could not diminish the light sufficiently without cutting down the object-glass to an inconvenient size, but in this way the light was so much reduced that there was a convenient unit to start with, and by turning the prism round in one and the Nicol's prism round in another direction they could diminish the light, and there was this advantage that you could calculate the diminution.

Mr. Ranyard: Is there any method of calculating the absorption in the Nicol's prism? Of course you could measure the absorption for any particular direction.

Mr. Christie: I fancy that the intensity of the light follows the ordinary law in a Nicol's prism as in others. Is there any difficulty about it?

Mr. Ranyard: The ray which gets through the Nicol's passes very near to the critical angle, in going through the film of Canada Balsam. Of course the loss of light might be determined by experiment for any particular direction.

Mr. Christie: There might be difficulties with a wide field, or if the Nicol is not properly in the middle of the field, but care is taken to bring the ray into the middle of the field. I do not think it would approach the critical angle very nearly, but I have not gone deeply into that part of the subject; it is a convenient method for comparing intensities within certain limits, but not for any great changes, and perhaps there might be some difficulty in calculating the loss at polarization.

The President: Even if there were some difficulty of that kind, I imagine that it would not be insuperable, and that the eye-piece would supply a convenient means of comparison.

Mr. Christie: There could be no difficulty in determining the law at different angles. It is essential, of course, that the object should be brought into a particular part of the field—the centre.

The President: This certainly makes a very compact form of eye-piece.

Mr. Christie: That was my only object in calling attention to it.

Mr. Dunkin read a note *On the variable star* S *Orionis*, by the Rev. T. W. Webb. The writer stated that having been informed that the star had been seen on November 7, 1873, considerable brightness, he took the opportunity of examining it on November the 16th, and subsequent observations proved that it was rapidly decreasing, and at the end of December he could hardly detect it. A very rough computation, founded on a graphic representation, indicated a period of fourteen months, agreeing with that deduced in a more accurate manner by Dr. Schönfeld; but the fluctuations in 1873 and 1874 were sufficient to raise a doubt as to the regularity of the variations, the period of the star required more prolonged attention. He was glad to see that Dr. Schönfeld was giving attention to the subject.

Mr. Dunkin then read a paper by Professor Winnecke *On some observations of the solar eclipse of Sept. 28th*, 1875, made at Strasburg. After some details as to the times, &c., the writer states that the lunar corrections he derived from the observations agreed closely with the Greenwich observations of the eclipse given in the November number of the *Monthly Notices.*

Mr. Dunkin remarked that it was very satisfactory to find that other observations agreed with Greenwich in giving the errors of the moon, almost identical with our own. Prof. Winnecke had used the semi-lunar diameter given in the *Nautical Almanack*, but at Greenwich they used the semi-diameter of the moon, determined from the eclipse observations in 1870, and the sun's semi-diameter from observations made with their transit-circle. That was the best they could do. No doubt the different values of semi-diameter at Greenwich and Strasburg would account for the small differences, and if both had used the same semi-diameter there would have been the same results. Mr. Dunkin went on to say, the Society was glad to receive these papers from foreign associates, because it showed the interest felt in English astronomy and the Royal Astronomical Society. (Hear, hear.) He believed the foreign astronomers did really look upon the *Monthly Notices* as the first astronomical journal of the day. This was not his (Mr. Dunkin's)

own opinion alone, but the opinion also of other astronomers of greater eminence than himself.

Mr. Dunkin said he had a most interesting paper *On the observations of the occultations of stars by the moon, and the phenomena of Jupiter's satellites,* made at the Royal Observatory, Greenwich, in 1875. It was full of figures and highly important, especially to those who desired to investigate the theory of the satellites.

Mr. Neison: How many occultations were observed?

Mr. Dunkin: I am sorry to say last year was a very bad year for astronomical observations, and we have only been able to obtain five occultations out of the list published in the *Nautical Almanack,* but we have a fair list of observations of Jupiter's satellites. To give an instance of the scantiness of the observations this year, they had in the last three months only obtained a book and a quarter full of transit observations at Greenwich, instead of the usual three books.

Capt. Noble: I went 11 nights without being able to get a clock star.

Mr. Dunkin: We have only had two really clear nights since the last meeting of the Society. I have also a valuable paper by Mr. Marth, entitled *An ephemeris for physical observations of Jupiter,* which it will be interesting to read in the *Monthly Notices.*

Mr. Dunkin then read a portion of a paper by Mr. Burnham *On the double stars Struve* 1156 *and* 1163. The paper stated that these were not two stars, but probably only one, there being no star in the place of Struve 1163. It was stated that in other instances double stars had been entered twice in the catalogues of Sir John Herschel. Mr. Dunkin remarked that he was happy to receive another contribution from Mr. Burnham, who was an indefatigable observer of double stars.

Mr. Dunkin next read a paper by Mr. Plummer *On the proper motion of Bradley's stars.* The writer thought his information would be valuable in view of the publication of an authoritative catalogue of stars. It was known that a great many stars in the British Association Catalogue, founded on Bradley's observations, were untrustworthy. He did not know whether it was right to assume that the proper motion must be constant in the 150 years that had elapsed since Bradley's observations, but he believed he had discovered some tendencies to the contrary. Then followed in the paper a tabular statement of the proper motions which the writer had determined taking the Greenwich and Armagh catalogues, and some of the differences were considerable.

Mr. Dunkin said he had another paper by Mr. Plummer *On astronomical nomenclature.* The author is not satisfied with the

present method of naming the stars, and desired a complete revolution in that respect, but Mr. Dunkin was afraid that the method Mr. Plummer proposed would create more confusion than good, because it would be impossible to identify the stars in the old and new catalogues. The minor planets he proposed to divide into classes according to their magnitudes, the first class being the brightest. Supposing they wanted to denominate a minor planet, say Egeria, by this method, it would be represented by a circle with the letters PL. within it in old English characters, then the class in Roman numerals, thus IV. and then 13 after that to denote the order of discovery. Mr. Dunkin gave several other instances of the changes of name proposed in the paper, and asked what good such a change would be.

Mr. Knobel: In reference to Mr. Plummer's suggestion, there is a catalogue of stars published in the last century, in which the stars were divided into classes.

Mr. Dunkin: It would be a laborious undertaking to classify the whole of the stars down to the 10th and 12th magnitude. We should never recollect them. Fancy speaking of class 6, No. 250,567. It is totally absurd.

Captain Noble: I do not think we can have a better illustration of the strong conservatism which exists with reference to star nomenclature than that afforded by the fact that in Mr. Proctor's excellent large atlas he changed the names of two or three of the old constellations for shorter or contracted names; but the whole thing has fallen as a dead letter. This has been the only attempt that I remember made to simplify the present system in my time, but it has come to nothing at all.

Mr. Dunkin: I must say that, having been an observer for thirty-seven years, I should really be exceedingly sorry to see the old names destroyed and upset for the sake of new-fangled notions. You know Sir John Herschel, many years ago, proposed to change the constellations to make them more symmetrical, but even his suggestion fell to the ground, though it came from so distinguished a man as Sir John Herschel.

Mr. Jackson: I remember that there was in the St. John's College Library when I was there an old atlas in which the constellations were changed for Christian symbols and the whole heavens were mapped out into new Christian constellations, instead of the old heathen ones.

Mr. Knobel: We have it in the library. It is by a German, in the last century, named

Mr. Dunkin proposed and Mr. Ranyard seconded a resolution to the effect that Messrs. Knobel, Barrow and Neison should be appointed auditors for the present year. It appears that it has

for many years been customary for the secretaries to propose the names of the auditors, but on the suggestion of Mr. Perigal that the auditors of the accounts ought to be proposed by independent members of the Society, the President requested that somebody would propose fresh auditors.

Mr. Perigal: I shall be very happy to propose the auditors: I have no objection to the gentlemen who were named, but, unfortunately, I forget who they were.

The President: As a matter of history I will mention that they were Mr. Knobel, Mr. Barrow and Mr. Neison.

The same names were then formally proposed by Mr. Perigal and seconded by Admiral Ommanney. The three gentlemen signified their willingness to serve and were appointed unanimously by the meeting.

Mr. Knobel stated that he wished to answer a question which had been put to a meeting of the Society a few months ago by Mr. Stone, Astronomer-Royal at the Cape, who had requested some information as to the original manuscripts of Sir Thomas Brisbane's catalogue. Mr. Knobel said that a short time back Mr. Wesley brought him some volumes he had found stored away in the store room of the Society. These he at once identified as the original MS. observations from which the "Paramatta Catalogue" was formed. They consisted of two volumes entitled, "Transit Observations, June 17, 1823, to Sept. 1, 1825," endorsed "Observations made by Sir Thomas Brisbane." Then came seven volumes entitled, "Circle Observations, June 17, 1823, to March 2, 1826." Three of these volumes are devoted to "Observations of South Polar distance, and volumes 4, 5, 6 and 7 are entitled, "Observations of Right Ascensions and Polar Distances made with the mural circle by James Dunlop." He supposed that the observations of right ascension were made with two instruments. He supposed there was a doubt about the right ascensions from a remark of Mr. Stone, in which he appeared to attach more value to the declinations. He thought that the Society would be interested to know that the old MSS. were in its possession.

The President: This information is extremely interesting and satisfactory.

Mr. Dunkin: I think we are obliged to Mr. Knobel for making this discovery, and if Mr. Stone had been in England he would have been glad to have seen these manuscripts whilst passing his paper "On southern proper motions" through the press.

Mr. Knobel: I at once wrote to Mr. Stone, but it was a week or two after he had left England.

Mr. Marth: If I remember rightly, Mr. Stone's question referred not so much to the original observations as to Richardson's

reductions. If the observations are here it is to be hoped that Richardson's reductions are also here.

Mr. Knobel: The MSS. are all endorsed, "Examined by Richardson."

Mr. Marth: Are the reductions with them?

Mr. Knobel said that they were not.

Mr. Marth: It would be as well to keep in mind that if the reductions can be found they should, if possible, be obtained for the Society.

The meeting adjourned at Half-past Nine. The following papers were taken as read:—

J. Tebbutt: *Eclipses of Jupiter's Satellites,* 1875.

J. Brett: *Note on Two Parallel Observations.*

Astronomer-Royal: *Occultations of Stars by the Moon and Phenomena of Jupiter's Satellites, observed at the Royal Observatory,* 1875.

E. B. Knobel: *On the Chronology of Star Catalogues.*

S. M. Drach: *Note on the Biblical Synodic Lunar Cycles.*

A. Marth: *Ephemeris for Physical Observations of Jupiter.*

REVIEWS.

Light as a Motive Power. A series of meteorological essays. By Lieut. R. H. Armit, R.N., late Admiralty assistant-surveyor, formerly employed in the Australian hydrographic surveys. Vol. I. London: J. D. Potter, 31, Poultry.

According to this theory "the globe is surrounded by a transparent spherical shell, enclosing within its folds the rising vapours from the earth, and preventing them from flying off into space" (p. 36). "The tract which creates the constant mineral volatization that turns the upper currents of our atmosphere into a metallic gas, is derived, not only from the sun, but also from the state of combustion [fusion] in which, it is believed, the centre of the earth exists" (p. 37). "It is only natural to conclude that all the minerals, volatised from a combination of causes, find their way into our atmosphere. If they do not do so, whence come the aerolites which nature precipitates at our feet, and which all reach the earth in the shape of bundles of highly-magnetised pure metal?" (pp. 37, 38, 62). "Heat, light, and cold are different forms of electricity" (p. 40). "The motive power of light produces the orbital motion and diurnal rotation of the celestial bodies, (pp. 45, 53—56) and the tides (p. 132)." "It may also be reasonably supposed that electro-magnetism plays an important part in guiding the wind through its circuits round the world" (p. 33.)

On aerolites our writer says: "We can understand that the accelerated speed that a mass of iron 80 lbs in weight would gain, in falling from the sun, moon, planets, or stars, would be such as to enable it, not only to embed itself in the soft soil of the earth to the depth of at most some *eight feet,* but literally to pierce it through and through, as a tallow candle fired from a fowling-piece pierces an inch board" (p. 274). This

is enormously exaggerated. Lieut. Armit should read what M. Flammarion writes on the "enormous dimensions of certain bolides and consequences of their falls upon the earth" (*Etudes et Lectures sur l'Astronomie,* Vol. v. pp. 182—186). Also the trajectory of the bolide of the 5th September, 1868, across the planetary system (Vol. iv. pp. 275—287). This body came from the depths of space, its absolute velocity being 43½ miles in a second, which increased to 62 miles at its perihelion. The nearest distance from the earth was 68 miles. Had this body come in contact with the earth by far the greater part of its immense velocity would have been lost in passing through the atmosphere, and the heat thus developed would have reduced it to fragments of dust. If any considerable portion had reached the earth it would have fallen with comparatively small velocity. The author continues, "Besides admitting that a star should burst, and send its fragments flying into space, which is impossible, as a shining body must have an atmosphere wherewith to reflect the light of the sun, where would the particles fall to, or in what direction would they fall? Most certainly in the direction of that point round which the whole universe revolves. Such being the case, and that point only being surmised to be somewhere in the constellation known as the Pleiades, and might as logically be taken to be the centre of the sun's orbit, why should an aerolite reach our earth? Again, the earth, being the centre of its own circle in space, would, according to the known rules of electricity, repel all bodies by the effect of its outer metallic envelope, and consequently no foreign body could ever come in contact with it. It is, therefore, self-evident that aerolites are formed within the earth's atmosphere, let it extend as high as it may above its surface, and this is further proved by their containing one-third of all the simple bodies known to exist on the earth" (pp. 72, 73). Upon all this we will only offer as comment a note of admiration.

We pass on to the theory of the winds, which occupies a large part of the volume, observing that here, as throughout the work, we find frequent and interesting quotations from well-known writers on meteorology, and narratives of the author's own experience in foreign parts, and many illustrative plates.

Lieut. Armit thinks that fogs affect the compass: "This variation is due to the difference between the terrestrial and atmospherical currents of electricity. On a fog coming on, it *insulates* the needle from the atmospheric current, and the terrestrial current, being the only one to influence it, either *reverses* the variation or *greatly increases it* " (p. 214). The recent loss of the "Schiller" is ascribed to this cause.

The author is evidently unaware of the astronomical considerations which prove the absence in the moon of an atmosphere of any appreciable extent. He could not otherwise have written the following among other paragraphs: "At the enormous distance that the moon is situated from the earth, such a small matter as 75 to 100 miles of metallic gas could hardly be noticed, and the only evidence of its presence would be its reflecting the light of the sun; this the moon does, and therefore it must have an atmosphere to reflect it by" (p. 342). And his astronomy is curiously at fault in the following: "But the moon always turns the same face to the earth, and from our terrestrial observations, fantastic steeples seem to stand out like phantoms in a glacial country. From this fact it seems obvious that we are constantly observing the moon's antartic or south pole, and that just in the same proportion that we find land, fantastic steeples, and craters of extinct volcanoes in the glacial cemetery of the earth's antartic regions, so do we observe the same formations within those regions in the moon. The apparent constant night of

that face of the moon which we observe, would thus be accounted for, as the sun's rays, although striking the outer atmosphere, would show no light upon the lunar poles. At the same time, the reflected light from the earth's atmosphere, together with the rays of the sun, would shed a constant white lime-like light over all that hemisphere of the moon presented to our view" (p. 345).

At the end of the book is a chapter on arctic exploration, in which the writer, who once served under Capt. Nares, gives his reasons for the Iceland and Spitzbergen route, and advocates a second expedition. He says: "Such an expedition could in no way interfere with, or detract from, the advantages to be reaped by the one that has just left our shores, under our late gallant commander, but, on the contrary, might be the means of rendering him most valuable assistance, by sending out boat and sledge parties in a westerly direction, so that in the event of his progress being impeded by vast mountains of ice, they would check his advance in a westerly direction, and bring him back to the only route by which, in our humble opinion, the north pole can successfully be reached" (p. 356).

We may observe that the passage Job xxxviii. 24, on which the author lays much stress (p. 16, &c.) is thus translated by many high authorities:

By what way is the light distributed,
And how is the east wind abroad upon the earth?

and this indeed seems preferable to the common version. That the latter is at least doubtful, makes it unsafe to rest anything material upon it.

Occasionally we come upon scraps of novel information, as (p. 19) ancient Ethiopian merchants are represented as "smoking their chebouk," and we are told that England was called "Anglia" at the time of the invasion by Cæsar (p. 27).

Written as they are by an intelligent and observant naval officer, these essays, and the information they bring together, may interest meteorologists apart from the peculiar hypothesis they are intended to support. There may very likely be more mysteries in light and electricity than we are at present aware of, but we fear the author has not unseldom mystified himself in the attempt to explain all phenomena by the (supposed) power of light. For an instance we would refer to the first 15 lines on page 45.

We are promised in the second volume the development of the theory on the circulation and currents of the ocean; the saltness of the sea, and a concluding chapter on NATURE regarded as a whole, in which the author will endeavour to reconcile scientific discoveries with the account given in the Bible of all natural phenomena, proving that there is only ONE LAW, ONE LIFE, and ONE DEATH in NATURE, and that the *primum mobile* is the invariably felt POWER OF LIGHT (Preface). With the tone of this work we have no fault to find. The writer does not forget the courtesies of life in the discussion of controverted questions, and this is some praise. Too often have the pages of science (as well as those of theology) been disfigured by the rudeness, the flippancy, or the oppressive egotism and self-assertion of their writers.

The Origin of the Stars, and the cause of their light. By Jacob Ennis, A.M. Principal of the Scientific and Classical Institute, Philadelphia, &c., &c. First London, from the South American, edition. London: Trübner and Co., Ludgate Hill. 1876.

Mr. Ennis claims to have made two great discoveries. 1. That gravity is the force which originally put all the heavens into motion. 2. That

chemical action is the cause of stellar light and heat. This which was believed by Newton, Laplace, and Davy, Mr. Ennis considers that he has successfully vindicated, by removing the only objections ever raised against it—want of fuel to keep up the burning long enough. He maintains that our earth and the sun are bodies of exactly the same nature, the difference being only a different stage in time. The fires which once lit up our globe in starlike splendour have long since gone out.

Part I. is on the *Cause of the light and heat of the sun and the other fixed stars.* Essentially, there is no distinction between fixed stars, suns, planets, and satellites. The light and heat of all are due to chemical action. Part II. is on the *Force which so greatly prolongs the light and heat of the sun and stars.* The chemical force, now active in the sun, is the conversion or conservation of the atomic force of repulsion which once held the solar system in a nebulous condition. That condition was one of inconceivable rarity,—many thousand billion times more rare than hydrogen. The force requisite to expand the sun so far must have been inconceivably great, and being indestructible must still exist; in fact, it is passing off as light and heat, being converted into chemical forces; and those methods are described by which this force operates: pp. 214, 215. Part III. is on *The origin of the stars.* Matter was diffused nearly equally through all space by the force of atomic repulsion, which was overcome by the same chemical force which overcomes repulsion in both hydrogen and oxygen, and causes their condensation into water. Contraction ensuing, the rarer portions of original matter would gather round the denser, and irregular masses be formed, like the clouds when the vapour in the air is contracting; and the author shows how gravity must operate at once to give both rotundity in form, and rotation in movement to every separate nebulous mass: pp. 220, 221. Other results are oblateness and centrifugal force: 224, 225. Part IV. is on the *Force which gave motion to the stars:* and Sir William Herschel's opinion is quoted, given in 1811, that gravity might be sufficient to produce rotation by means of the prominences or "eccentric matter" of a nebulous mass. These in displacing other matter, or in sliding down sideways, must produce a circular motion. He did not, however, distinctly see, Mr. Ennis says—1st. That the sliding down sideways of this eccentric matter would produce many currents, in various directions, especially when aided by gravity from other nebulæ. 2nd. That these currents must ultimately all result into one. 3rd. That this one current could not possibly stop, but must, of necessity, go on faster and faster every moment, in consequence of the continued action of gravity, and the contraction of the nebulous globe: p. 333. By regarding gravity not only as the original cause of rotation, but as the cause of the increased velocity of rotation, we can calculate from time to time how rapidly the nebulous mass must have rotated, and then we discover that the rotation must have coincided with the present planetary velocities, after all necessary friction is allowed. That same friction accounts for the decreased velocity of the sun's equator in the present era: p. 347.

According to the nebula theory, as presented in this volume, all the space within the ring of the Milky Way was occupied by matter in a nebulous condition, which broke up into stars. The matter of our own solar system, nearly all of which is now in the sun, occupied the space until half way to the nearest fixed stars. Assuming these to be little more than 20,000,000,000 miles distant, then the space occupied by the sun extended more than 3,622 times further every day than the distance of Neptune. But we have already seen that the sun, when expanded to the orbit of Neptune, was 14,000,000 times less dense than hydrogen.

Therefore, when expanded 3,622 times farther, it must have been 666,000,000,000,000,000 times less dense than hydrogen. This great number expresses the repulsive force which then resided in the sun and separated its particles: p. 348.

In his opening address to the astronomers of Great Britain and others, the author expresses his earnest solicitude about the reception of his work in this country. From the reviewers he asks a good word to draw attention to his labours, which have been attended with great sacrifices of time and expense. We find it impossible to give more than a general idea of this book, with nearly 400 closely printed pages, and which claims to account for every known phenomenon of the stars and of our own system. On so vast a subject we cannot pretend to pronounce an ex-cathedrâ judgment, but having read the work through, we think its perusal will interest astronomers, whether or not they are led to agree with its author about his two leading discoveries (or, as we should have preferred to say, theories); on behalf of which he has, as it appears to us, adduced many plausible considerations. He promises another volume on the History of Creation.

On the Necessity of a Mechanical Laboratory; its Province and its Methods. By Prof. R. H. Thurston, A.M., C.E. Reprinted from the Journal of the Franklin Institute, December, 1875. Philadelphia, pp. 10.

Prof. Thurston says, "There are few men of any considerable practical experience in engineering who have not felt the great need of some well-established and reliable authority to which they could apply for special information, either purely scientific or more strictly professional, bearing upon unfamiliar details of their work." The necessity of a mechanical laboratory is made very clear in this pamphlet, and we are glad to find that the trustees of the Stevens' Institute of Technology have consented to inaugurate one. The scheme is also suggested by other societies and individuals. We cordially wish it success. Amongst other advantages to be gained by it, well pointed out by Prof. T., "the application of scientific knowledge to familiar work and to matters of business" will not be the least.

THE UNIVERSE OF THE ESQUIMAUX OF GREENLAND.

Mythology of the Esquimaux of Greenland. (Mythologie et legendes des Esquimaux du Groenland. Par l'Abbé Merillot. Paris: Maisonneuve et Cie., 1874.*)* From the *Saturday Review*, June 12th, 1875.

"According to the tradition of the Esquimaux, the whole world is inhabited by demons; but these are under the control of a superior being named Tôrnâsuk . . . The residence of Tôrnâsuk is in the lower world, a distinct region, apart from our earth and sea, which are supported by pillars. It may be reached by water and through crevices in the earth. The upper world, on the other hand, is but a continuation of our own, containing mountains, valleys, lakes—in fact, every variety of things terrestrial—and may be reached by an ascent from the middle of the ocean. As for the stellar sky immediately above us, it consists of a solid material, and moves on the summits of a mountain situated in the north, and probably forming part of the upper world. To one of the two worlds the souls of all the departed are compelled to go, their

lot being decided by the decree of Tôrnâsuk. The lower is better than the upper world, abounding as it does in heat and food; but the blessed, whose abode it is to be, cannot reach it without gliding for five days upon craggy rocks. The souls in the upper world dwell in tents, situated on the banks of frozen lakes, and suffer from cold and hunger. Their amusement is to play at tennis, with the heads of the hippopotamus for balls, and this recreation, by what process it is hard to explain, is the Aurora Borealis. What we have here stated accords with the primitive belief of the Esquimaux. Those who have been converted to Christianity place their paradise above the solid vault of the sky, but immediately below it the awful tennis-players continue their sport, and when the Aurora Borealis appears it is not safe to take one's walks abroad, as the spirits are likely to leave off their game, and, descending through the air, to carry off the living.

"Greenland was discovered towards the end of the tenth century by Eirik, a Norwegian, who gave it the name which it still bears (Groenland). . . . The origin of the Esquimaux is a matter of dispute. Some would trace them to Asia, others would derive them from America, and it is to the former view that M. Merillot inclines."

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

ESTIMATING DISTANCES AND ANGLES OF DOUBLE STARS.

In the several Catalogues of New Double Stars published from time to time in the last two or three years, I have given the angles and distances, for the most part, without micrometrical measurements. The results of a comparison of these estimates with the careful measures of Baron Dembowski, made subsequently and as yet unpublished, may be interesting as showing the value and probable error of the unaided eye in such observations. The stars are divided into two classes; the first where the distance of the components is less than 1″, and the second where the distance is above 1″ and not exceeding 5″, and every available observation has been made use of.

From 0″ to 1″	...	Mean error of D = 0″·11	(38)
		„ „ „ P = 10°.2	(37)
From 1″ to 5″	...	Mean error of D = 0″·45	(84)
		„ „ „ P = 8°.3	(74)

The number of stars from which the average error is derived is given in parentheses.

Chicago: Dec. 31, 1875. S. W. BURNHAM.

METEORS SEEN IN DECEMBER.

Sir,—During the few fine nights we had in December bright meteors were somewhat frequent, and as they may have been noticed at other places the brief notes which follow may be of some use:—

Dec. 12.—6.29, 2nd mag. Shot through Ursa Minor and Dracos' head towards α Lyræ as if from α Aurigæ. Very rapid.

Dec. 12.—6.36. = ♂. Traversed a short and horizontal path just below μ and λ Ursæ Majoris. Radiant at θ Geminorum. Very slow and red. Near horizon.

Dec. 13.—10.8. = ♃. From direction of moon and just under β Ursæ Majoris. Very slow, no train, same radiant as last.

Dec. 19.—6.15. An intense flash, probably of meteoric origin, seen in a clear sky.

Dec. 23.—7.35. 2nd mag. Shot between Polaris and (towards) β Aurigæ from χ Draconis.

Dec. 23.—8.44. = ♃. Passed over μ Geminorum from Polaris (?radiant in Draco). No train. It had a long path and the motion was moderately swift.

Dec. 23.—9.27. 1st mag. Over ϵ Cassiopeiæ towards α Cygni. Short path, very transient. From Auriga.

Dec. 23.—10 0.—3rd mag. 15° left of η Ursæ Majoris. Horizontal motion from direction of this star. No train.

In addition to these many smaller meteors were seen. Most of them displayed the same features. They were generally trainless and rolled along the sky with very gradual motion, differing materially from the transient bodies visible at some seasons.

I may add a note on a Fireball, seen in bright sunshine on Dec. 22. It appears to have been observed at three different places and the accounts, no doubt, refer to the same object. Mr. H. J. Powell, writing to me from Dorking, says: "Its course was from S.S.E. to N.N.W. It had no well defined outline like the moon, but was merely an irregular luminous ball. Its size as compared with the moon was about one-sixth. The motion was not a very rapid one. I heard no sound after its disappearance." Writing to the *Times*, Mr. Powell also mentioned that "it left a long trail of fire behind it," and the nucleus "broke up and disappeared before it reached the horizon." The time was about 1.38 p.m. Another observer writing from Southampton says: "In the full blaze of a sun—a rare sight in itself now-a-days—I observed a bright meteor traversing the sky from south-west to north-east, in form like a common rocket. Time 1h. 38m. 45s. p.m." The close agreement in the times is striking, and conclusive as to the identity of the object seen at the two places. In *Nature*, Jan. 6, Mr. Webb also refers to a meteor, seen at Hardwick on "Dec. 22, about 2 p.m., descending in the E. with a little inclination to the N.;" and described to him as larger than Mars or Saturn, though not so large as the moon. The three accounts, no doubt, relate to the same fireball, though in the latter case the time (which, however, seems merely intended as approximate) is 22m. in advance. Besides, there is a coincidence in the observed paths at the two latter stations which is sufficient to remove any doubts in the matter.

A meteor seen under such conditions must be a rarity, and I have met with no account of such a phenomenon since the daylight meteor of Nov. 3, 1868, 3.22 p.m.

Your obedient servant,

Bristol: Jan. 6, 1876. W. F. DENNING.

STAR MAGNITUDES.

Sir,—In reference to Mr. Chambers' observations in the last number of the *Register*, I can quite corroborate the statement that magnitudes not based on methodical experiments are rarely trustworthy.

Often you see with a large aperture what appears to be an exceedingly minute star, in fact, apparently, a minimum visible; but on reducing the aperture, to perhaps one-half, you are amazed to find the minimum still visible. I have noticed this particularly with blue stars.

But even in determining magnitudes by methodical experiment several precautions are necessary. For instance, it is not safe to determine the magnitude by means of the extinguishing aperture only; for the eye trained by slow degrees, by gradual reductions of aperture, will continue to follow the well-known object amid its familiar surroundings long after the light has been diminished to such an amount as would be insufficient to show it as a new object. Therefore, I think, it is prudent to determine the magnitude both by the use of decreasing apertures till you arrive at the extinguishing one, and also by the use of increasing apertures till you arrive at the exhibiting one.

Then, again, as to the application of various apertures to an object glass, it may be ten or twelve feet from the ground. It will scarcely do for the observer to go up a ladder to the object glass, nor yet will it do to bring the object glass down to the observer: for, in the first place, there would be much time lost in resetting the circle to find the object; secondly, the eye would be dazzled by the light used in setting; and, thirdly, the definition would be impaired by the constant churning up and down of the air contained within the telescope.

To obviate these inconveniences Mr. Carrington invented an hexagonal, and Mr. Knobel, I believe, a triangular aperture, each of which could be diminished at pleasure from the eye end of the telescope.

But I fear it would be scarcely safe to compare, directly, results given by hexagonal or triangular areas with those given by equal circular areas; for, with angular apertures a portion of the light of the star, a minute portion it is true, is distributed in rays proceeding from the star; while with circular areas the light is distributed round about the star itself.

I also had arranged a disc revolving outside the object glass on a centre attached to the exterior of the tube; the disc was perforated with known apertures and could be made to revolve from the eye end in such a manner as to bring any desired aperture before the object glass. This contrivance was convenient, and answered well when there was no wind; but it was heavy and useless in any considerable wind, whereas perfectly calm nights are not the best for estimation of magnitudes, by reason of the abundant dew-fall then prevailing; however, for larger magnitudes, such as can be reached with the finder, it answers admirably.

Latterly I have used a long fine rod, split, not sawn, tapering to one end, at which is hinged with friction, an arm eight inches long, having at its free end an oblique saw slit an inch deep. Into this slit the required diaphragm is hung, then by turning the arm till it becomes parallel to the object glass, in whatever position that may be, the diaphragm is very easily introduced into the end of dew-shade, and as easily withdrawn when required. The upper end of the long rod will be very much more easily directed if the lower end, below the hand, carry a suitable counterpoise. The diaphragms are easily cut out of thin zinc.

The most important part remains, viz., to determine the aperture corresponding, for each individual, to a given Struvian magnitude.

I cannot agree in thinking that this is best done by determining the aperture for a 6th magnitude, and from that, as basis, working upward, for by so doing a small error would become greatly magnified. I prefer to ascertain the aperture corresponding to the mean of several faint stars,

say 11 and 12 Struve, and thence obtain, by continual halving, the aperture corresponding to the brighter magnitudes.

In order to render the magnitudes of different observers comparable *inter se*, it would be desirable that each should give a few specimen stars with corresponding apertures. The specimen should be selected near the pole; and for convenience of identification, they should be each in a large field with some brighter star which could be excluded by the use of a small field. I am able to see the comes of α Lyræ, distant 40 seconds, with an aperture of 2·1 inches, and power 100.

Soon after obtaining my 7½ inch Alvan Clarke, I tried how far it would reach towards Struve's minima with his 9½ inch telescope; and, to my great surprise, found that I could see all his "Difficillissima" in the matter of light; not of course in the matter of proximity. This enormous difference of vision shows how necessary it is for each person to determine his own aperture. Those I have adopted are:—

For 12 mag., 8 inches; 11 mag., 4 inches; 10 mag., 2 inches; 9 mag., 1 inch; 8 mag., ½ inch; 7 mag., ¼ inch; 6 mag., ⅛ inch.

In order to prevent waste of time in trying to attain unattainable precision in estimating magnitude, it is well for each person to try his own powers in this respect. Much, I believe, depends on the state of the digestive organs. Though mine are good, I cannot at a single observation determine within a quarter of a Struvian magnitude; or, in other words, if 8 inches were required to show a certain star with certainty, it might be necessary to reduce the aperture to 7 inches in order to extinguish the said star beyond the possibility of doubt.

I am,
Faithfully yours,
WENTWORTH ERCK.

Sherrington Bray:
January, 1876.

LUNAR OBJECTS SUITABLE FOR OBSERVATION IN FEBRUARY, 1876.

By W. R. Birt, F.R.A.S., F.M.S.

Revision of Zone II. 0° to 5° S. latitude; see Vol. XI. p. 214. As in January, the objects are expressed by numbers.

424, (*a*) 346, 327, (*b*) 506,* 520,* (*c*) 325d, 317, 301, 298, 297, 460, 104 (*d'*), 287, 498†, 211, 210 (*e*), 222, 223 (*f*), 271, 272, 153, 507†, 273. (*g*)

Points of the First Order.

			°	′	″		°	′	″	
W. longitude	B	Messier	47	9	12	...	1	38	55	S. lat.
„	B	Censorinus	32	21	31	...	0	26	35	„
„	B	Delambre	17	15	9	...	1	47	17	„
E. „	W	Wichmann (*h*)	5	13	56	...	3	10	25	„
„	N	Mösting	5	33	2	...	0	36	26	„
„	N	Lalande	8	47	41	...	4	26	34	„
„	N	Landsberg	26	18	49	...	0	25	28	„
„	B	Flamsteed	44	12	8	...	4	30	48	„
„	B	McClintock (*i*)	70	53	28	...	4	54	27	„

Notes.—For the signification of the asterisks (*) and daggers (†) see note (*a*), *ante* p. 23.

(*a*) For Schröter's drawings of the *Mare Smythii*, under the name Kästner. See Tafel LIX. fig. 1 of his Fragments.

(*b*) For illustrations of *Messier*, between 1864 and 1874, consult "Selections from the Portfolios of the Editor of the Lunar Map and Catalogue," second issue, p. 19. Also "Webb's Celestial Objects," third edition, p. 116. Messier is one of the objects in which Webb considers we have strong evidence of *modern physical change.*

(*c*) The names *Alcuinus* (506) and *Beda* (520) were given by Riccioli; the objects are both described in "Brewster's Ferguson," Vol II. p. 161, as "annular with central mountain." *Alcuinus* is placed by Lambert in 39° W. and 3° S., and *Beda* in 37° W. and 2° S. This region should be carefully explored as B. and M. have not given these names on their map, but they appear to be designated *Alcuinus* by *f*, and *Beda* by *d*, in area IV. B γ (35° to 40° W.; 0° to 5° S.) In my Register I describe *Alcuinus* as a small crater S.W. of *Censorinus*, and E.S.E. of *Messier* A, and I add this note under date 1866, February 13, "B. and M. regard the position of *Alcuinus* (R) as doubtful. This crater *f* is near the position assigned by Riccioli to *Alcuinus*, and is the brightest in the immediate neighbourhood. I have accordingly restored *Alcuinus* to the nomenclature." This restoration was overlooked when I handed Mr. Webb the additions published in the third edition of his "Celestial Objects."

(*d*) Lambert gives in 31° W. and 3° S. a spot named by Riccioli "Dionysius Exiguus," but no description of it. It is M. Herculis of Hevel. Will observers please examine the locality?

(*d*) In this zone, between 0° and 10° of W. longitude, 216 objects at least have been examined; they are described in the Reports of the British Association for the Advancement of Science, 1866 and 1868. An identification of them by recent observers will be valuable.

(*e*) Lambert gives in 20° E. and 2° S. a spot named by Riccioli "Molinus," and by Hevel "Insula Zachintus." There is no vestige of it in B. and M. either map or text. Perhaps not being able to find it, they queried "Parry" as being Riccioli's object. (See "Der Mond" p. 311 § 317.) A dark spot near this locality exists in Mayer's map.

(*f*) "Linnemann" is another of Lambert's spots from Riccioli, not in B. and M., locality 55° E. on the equator. Tobias Mayer, in his map (reproduced by Brewster in his edition of "Ferguson's Astronomy," published in 1821) has a very decided well-marked ringed crater, *exactly* in this place. It is, however, absent from the list of 89 spots, the positions of which were determined by Mayer.

(*g*) In the examination of Zones I and II it is recommended to observe on every fine evening the objects specified that may be near the morning and evening terminators, and also under the higher lights. A good method would be to select two or three objects for observation during a lunation.

(*h*) Not having received a negative to my suggestion (see *ante*, p. 18), that Mösting A should be named "Wichmann" (498), I have included it under that name in the above list of points of the First Order in Zone II, and not "Kaiser," as suggested in August, 1873. See Vol. XI. p. 214.

(*i*) This is Grimaldi A of B. and M. (507), who record it as shining with 6° of light at their epoch. Observers are requested to note the degrees of lustre of the brighter objects in this Zone and also those in Zone I.

Books Received.—"On the Necessity of a Mechanical Laboratory." By Professor R. H. Thurston. Philadelphia, 1875.—"Greenwich Astronomical Results for 1873."

ASTRONOMICAL OCCURRENCES FOR FEBRUARY, 1876.

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. Procyon
Tues	1	5 58 6 59	Occultation of π Piscium (6) Reappearance of ditto Sidereal Time at Mean Noon, 20h. 44m. 11·40s.			10 46·9
Wed	2	13 53 6 31 7 33	☽ Moon's First Quarter Occultation of 27 Arietis (6) Reappearance of ditto			10 42·9
Thur	3	7 4 8 17 11 47 12 6	Occultation of 66 Arietis (6½) Reappearance of ditto Occultation of 9 Tauri (6) Reappearance of ditto			10 39·0
Fri	4		Sun's Meridian Passage 14m. 9·60s. after Mean Noon	1st Ec. D.	17 7 7	10 35·1
Sat	5	7 43 15 9 15 29	Near approach of B.A.C. 1746 (6½) Occultation of 136 Tauri (5) Reappearance of ditto Saturn's Ring: Major axis=[illegible]1"·82 Minor axis=[illegible]"·54	1st Tr. I. 2nd Sh. I. 1st Sh. E. 1st Tr. E. 2nd Tr. I. 2nd Sh. E.	15 40 16 29 16 39 17 52 18 53 19 2	10 31·1
Sun	6	21	Opposition of Uranus to the Sun	1st Oc. R.	15 18	10 27·2
Mon	7			2nd Oc. R. 3rd Ec. D. 3rd Ec. R.	15 56 16 8 26 17 48 14	10 23·3
Tues	8					10 19·4
Wed	9	5 46 19 35	○ Full Moon Near approach of 34 Leonis (6)			10 15·4
Thur	10					10 11·5
Fri	11	8 29 9 24	Occultation of 89 Leonis (6) Reappearance of ditto	1st Ec. D.	19 10 35	10 7·5
Sat	12	12 50 14 41 15 54 18 10 19 15 17	Near approach of B.A.C. 4200 (6) Occultation of B.A.C. 4225 (6½) Reappearance of ditto Occultation of f Virginis (6) Reappearance of ditto Inferior conjunction of Mercury and Sun	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Sh. I.	16 20 17 35 18 32 19 5	10 3·6

DATE.			Principal Occurrences.	Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Sun	13	14 0	Near approach of 58 Virginis (6)	1st Oc. R.	17 3	Procyon 9 59·7
Mon	14		Sidereal Time at Mean Noon 21h. 35m. 26·63s. Illuminated portion of disc of Venus=0·820 Illuminated portion of disc of Mars=0·919	1st Tr. E. 2nd Oc. R.	14 15 18 31	9 55·7
Tues	15	17 23	Near approach of B.A.C. 4923 (6)			9 51·8
Wed	16	16 55	☾ Moon's Last Quarter			9 47·9
Thur	17	1 9	Conjunction of Moon and Jupiter, 5° 54′ N. Conjunction of Saturn and Sun			9 43·9
Fri	18		Sun's Meridian Passage 14m. 11·95s. after Mean Noon	3rd Tr. I. 3rd Tr. E.	14 56 16 36	9 40·0
Sat	19	16	Jupiter at quadrature with the Sun	1st Sh. I.	18 13	9 36·1
Sun	20			1st Ec. D. 1st Oc. R.	15 32 27 18 57	9 32·1
Mon	21			1st Tr. I. 1st Sh. E. 2nd Ec. D. 1st Tr. E.	13 56 14 53 16 7 17 16 8	9 28·2
Tues	22	23	Conjunction of Moon and Mercury 6° 33′ N.			9 24·3
Wed	23			2nd Tr. I. 2nd Sh. E. 2nd Tr. E.	13 26 13 31 15 58	9 20·4
Thur	24	18 20 5	● New Moon Conjunction of Moon and Saturn 1° 23′ N.			9 16·4
Fri	25		Saturn's Ring: Major axis=34″·79 Minor axis=5″·89	3rd Sh. I. 3rd Sh. E. 3rd Tr. I.	13 44 15 40 18 54	9 12·5
Sat	26					9 8·5
Sun	27	19 20	Conjunction of Jupiter and β Scorpii 0° 1′ N. Conjunction of Moon and Venus 1° 53′ S.	1st Ec. D.	17 25 53	9 4·6
Mon	28	23	Conjunction of Moon and Mars 2° 42′ S.	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E. 2nd Ec. D.	14 34 15 49 16 46 18 0 18 40 11	9 0·7
Tues	29			1st Oc. R.	15 18	8 56·7
MAR. Wed	1			2nd Sh. I. 2nd Tr. I. 2nd Sh. E. 2nd Tr. E.	13 34 16 0 16 7 18 32	8 52·8

THE PLANETS FOR FEBRUARY.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	22 4 50	S. 10 31	7″·8	1 20·4
	9th	21 55 11	S. 9 5½	9″·3	0 39·3
	17th	21 18 25	S. 12 6	10″·3	23 27·3
	25th	21 7 31	S. 14 34	9″·3	22 45·0
Venus ...	1st	23 1 30	S. 7 41	12″·3	2 16·9
	9th	23 37 19	S. 3 35½	12″·7	2 21·2
	17th	0 12 31	N. 0 35½	13″·2	2 24·9
	25th	0 47 26	N. 4 47	13″·7	2 28·2
Jupiter ...	1st	15 48 15	S. 19 1	33″·1	19 0·9
	9th	15 52 4	S. 19 12	33″·9	18 33·3
	17th	15 55 15	S. 19 20½	34″·5	18 5·0
	25th	15 57 43	S. 19 27	35″·5	17 36·0
Uranus ...	2nd	9 23 24	N. 16 6	4″·2	12 33·2
	18th	9 20 39	N. 16 18½	4″·2	11 26·6
Neptune ...	2nd	1 55 41	N. 9 59		5 6·7
	18th	1 56 38	N. 10 5		4 4·8

Mercury sets on the 1st of the month one hour and three quarters after the sun, the interval rapidly decreasing. In the middle of the month he will rise half an hour before the sun, the interval increasing to one hour.

Venus sets about three hours after the sun at the beginning of the month, the interval slightly increasing.

Jupiter rises about two hours after midnight, the interval decreasing. He is in quadrature with the sun on the 20th.

EPHEMERIS FOR PHYSICAL OBSERVATIONS OF JUPITER.

Greenwich. Midnight.	Longitude of ♃'s central merid.		Angle of position of ♃'s axis.	Annual parallax.	Latitude of earth	Latitude of sun above ♃'s equator.
	°	°	°	°	°	°
Feb. 15	24·9	870·6	12·18	—10·52	—3·13	—3·06
16	175·5	·6	12·14	10·53		
17	326·1	·6	12·11	10·54		
18	116·7	·6	12·07	10·55		
19	267·3	·6	12·04	10·56		
20	57·9	·6	12·01	—10·57	—3·14	—3·06
21	208·5	·6	11·98	10·56		
22	359·1	·7	11·95	10·55		
23	149·8	·6	11·92	10·54		
24	300·4	·6	11·90	10·53		
25	91·0	·6	11·87	10·52	—3·15	—3·05
26	241·6	·6	11·84	10·50		
27	32·2	·6	11·82	—10·48		
28	182·8	·7	11·80	10·46		
29	333·5	870·6	11·78	10·44		
March 1	124·1		11·76	10·41	—3·16	—3·05

The "Annual parallax" is the difference of the sun's and earth's longitude, as seen from Jupiter, and reckoned in the plane of his equator.

To find the longitude of central meridian

For 13h. add $36^\circ{\cdot}3$ to the longitude at midnight.
14h. $72^\circ{\cdot}6$
15h. $108^\circ{\cdot}8$
16h. $145^\circ{\cdot}1$

Vide page 80 of last vol. A. M.

EPHEMERIS OF THE SATELLITES OF URANUS.

1876. 12h. Gr.	Ariel. pos. °	Ariel. dist. ″	Umbriel. pos. °	Umbriel. dist. ″	Titania. pos. °	Titania. dist. ″	Oberon. pos. °	Oberon. dist. ″
Feb. 1	298	7	205	18	34	27	359	44*
2	165	12	157	15	11	35	342	35
3	6	15	29	17	350	29	310	24
4	204	14	342	16	303	17	255	23
5	57	9	214	16	228	22	219	33
6	309	8	173	19	198	33	201	43
7	169	13	39	15	178	33	188	46
8	8	15	351	18	145	21	175	42
9	208	13	225	14	68	18	155	32
10	66	8	175	19	26	30	116	22
11	318	9	53	13	5	34	63	25
12	172	13	358	20	341	26	33	36
13	11	15	241	12	278	16	17	45
14	212	12	181	20	216	26	5	46
15	77	8	72	11	191	34	350	40
16	326	9	4	21	171	30	327	29
17	176	14	264	10	127	18	281	22
18	14	15	186	21	51	21	233	28
19	216	11	97	10	19	33	209	39
20	89	7	10	21	359	33	193	46
21	332	10	291	10	328	22	181	45
22	179	14	193	21	253	18	165	37
23	17	15	123	11	207	30	137	26
24	222	11	16	21	184	35	84	22
25	101	7	313	12	162	27	45	31
26	338	11	199	20	103	16	24	41
27	181	15	142	13	39	25	10	46
28	20	14	22	19	13	34	357	43
29	228	10	330	14	352	31	339	34
March 1	113	7	206	18	311	19	305	24

* By an unlucky clerical error the positions of Oberon and Titania for January, at page 19, are all placed two lines too high, or belong to dates which are two days later. Their positions for the first two days are—

Jan. 1	236°	19″	94°	20″
2	201°	31″	47°	28″

The positions of Ariel and Umbriel are correctly copied.

A. MARTH.

DISCOVERY OF NEW PLANET (158).

(From *Astronomische Nachrichten*, No. 2,072.)

On the night of the 4th of January I was occupying myself with the re-discovery of (140) Siwa, but found upon that occasion a new planet, which I have observed as follows:—

1876. Jan.	M.T. Berlin. h.	m.	s.	R.A. h.	m.	s.	Declination. °	′	″
4	15	22	31	7	19	58·36	+ 22	1	59·3
4	16	36	27	7	19	55·57	+ 22	2	1.7
8	15	1	3	7	16	8.32	+ 22	7	39·8

The planet appeared to me like a star of the 11th or 12th magnitude.

Berlin: 12th January, 1876. V. KNORRE.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To May, 1875.
Linwood, Rev. W.

To Sept., 1875.
Heming, Rev. B. F.

To Dec., 1875.
Clark, Miss
Cunningham, G.
Dallmeyar, J. H.
De la Rue, W.
Dobie, Dr.
Erck, W.
Hollis, W. H.
Jackson-Gwilt, Mrs. H.
Horner, Rev. J.
Lancaster, J. L.
Lancaster, W. L.
Little, W.
Locke, W.
Wilson, J. M.
Woodman, T. C.

To March, 1876.
Guyon, G.
Wright, Rev. W. H.

To April, 1876.
Lawton, W.

To June, 1876.
Buffnam, T. H.
Burnham, S. W.
Metcalfe, Rev. W. R.
Noble, Captain W.
Prince, C. L.

To Dec., 1876.
Clermont, Lord
Collingwood, E. J.
Ellis, W. M.
Gilby, J.
Goode, J. F.
Hall, Rev. R.
Hunt, G.
Knott, G.
Lambert, O.
Lettsom, W. G.
Monckhoven, Dr. V.
Monk, Dr.
Numsen, W. H.
Perigal, H.
Ranyard, A. C.
Redpath, H. S.
Schaferik, Dr.
Smyth, Prof. P.
Stothard, Dr.
Terry, J.
Tidmarsh, J. B.
Vernon, G. V.
Waldegrave, Hon. H. N.
Whitbread, S. C.
Wilson, T.

TO CORRESPONDENTS.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to John C. Jackson, at Lower Clapton, London, E.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications, Letters, Articles for insertion, &c., must be sent to the Rev. J. C. Jackson, *Clarence Road, Clapton, E.*, **not later than the 15th of the Month.**

The Astronomical Register.

No. 159. MARCH. 1876.

ROYAL ASTRONOMICAL SOCIETY.

Session 1875—76.

Anniversary Meeting, February 11th, 1876.

Professor Adams, F.R.S., *President*, in the Chair.

Secretaries—Mr. Dunkin and Mr. Ranyard.

The minutes of the last Anniversary Meeting were read and confirmed.

The following candidates for the fellowship of the Society were balloted for and duly elected:

Rev. Wm. Jackson, M.A., Worcester College, Oxford.
Rev. Edmund Ledger, M.A., Gresham Professor of Astronomy, Duxford Rectory, Cambridgeshire.
John J. Plummer, Esq., M.A., Orwell Park Observatory, Ipswich.
Rev. Walter J. B. Richards, S. Mary of the Angels, Bayswater.
Edwin John Sykes, Esq., 5, The Quadrant, Brixton.
John Walden, Esq., The Observatory, York Street, Jersey.

Mr. Garnett suggested that some of the earlier volumes of the *Notices* might be printed, so as to make complete sets. He said he had applied for some numbers, and the Assistant Secretary had said he could not supply them, as there were so few in stock.

The President said this was a matter for the Council, who, no doubt, would be glad to know what the demand was likely to be for the numbers if reprinted.

Mr. Brewin asked that the report of the auditors for the previous year might be read and also printed, if that of the present year was printed, as that for last year was not printed or read, and the report which had just been read referred to it.

The President said that this request was not in order now.

Mr. Dunkin said it should be made after the President's address.

Part of the annual report and the report of the auditors was read by Mr. Dunkin. The accounts of the Society show that its affairs are in a prosperous condition. A sum of £448 has been collected during the past year as arrears of subscriptions. The number of Fellows has increased by 13, giving a present total of 566 Fellows. The Society has been living within its income, and a sum of £2,000 has been left to it by Mr. Carrington, one of its deceased Fellows.

The life of Mr. Carrington was read at length. It appeared that the chief mass of his work—namely, the preparation of the Redhill catalogue of circumpolar stars, and the observations and reductions necessary for the preparation of his great book upon sunspots was all done within a period of some twelve years after he left Cambridge. During the same period he served as secretary of the Society, and was in active correspondence with most of the astronomers of Europe. After that time the death of his father made it necessary for him to devote himself to the business of a brewer, and during the latter part of his life he suffered from the effects of illness, which is now supposed to have been caused by the bursting of a small blood-vessel on the brain. Mr. Carrington died at his observatory, which was situated on a conical hill, called the Middle-Devil's-Jump, near Churt, in Surrey. Parts of the lives of Professor Selwyn and Mr. Vignoles were also read. Amongst the deceased associates of the Society are Dr. Argelander, M. D'Arrest, and M. Louis Mathieu.

Under the head of the progress of astronomy during the past year, the report contained an account of the observations of the total eclipse of the sun in April, 1875. Seventeen minor planets have been discovered since the last anniversary of the Society. In the month of November alone six were discovered in Europe. The number of known members of this remarkable group of minute planetary objects now amounts to 159. The astronomers who have been most active in this department of astronomy are MM. Palisa, of Pola; Peters, of Clinton, U. S.; Borrelly, of Marseilles; and Prosper Henry, of Paris.

In striking contrast to the unusually large number of planetary discoveries, no fresh discovery has been announced in the cometary system in the past year. Encke's comet, however, approached to perihelion, and has been closely observed. Dr. Von Asten, who has had the comet under his care for some years past, has made some remarks which are very interesting as bearing upon the undecided question of the so-called "resisting medium." That an acceleration in the period of the comet has taken place does not now admit of doubt, but there are some remarkable facts in connection with it which still await their final solution. The

acceleration did not take place till at or near the perihelion passage of 1868, and Dr. Von Asten finds that the observations of 1865 and 1871 are perfectly consistent with the supposition that the comet moved between those times according to the ordinary laws of gravitation, without any effect traceable to a resisting medium, or any other extraneous cause of disturbance other than the planetary perturbations. A consideration of the whole matter, and of Encke's calculations, has convinced Dr. Von Asten that the elements of the comet suffer changes in the immediate neighbourhood of the perihelion which cannot be explained by the theory of a resisting medium, and rather carry one back to Bessel's opinion that the disturbance to which the body is subject is closely connected with the out-streaming phenomena.

M. Leveau, of the Paris Observatory, has made a new and elaborate investigation of the perturbations of D'Arrest's periodical comet. An account of this investigation is given. Reference is also made to the new volume of the "Moscow Observations," and to M. Wolf's "Series of Measurements and Catalogue of the Pleiades Group."

An account is also given of Mr. Stone's work "On the Proper Motion of Southern Stars," and of Struve's "Observations of the double star Σ 634," and of Doberck's "New Elements of the Orbits of Binary Stars."

A paragraph is devoted to Dr. Schjellerup's translation of Al Sufi's catalogue of fixed stars. Al Sufi was a Persian, born about the year 900. He appears to have been a man of great natural talent, living at the court of Shiraz and Bagdad, where he was in great favour with the reigning prince, for whose instruction his work on the stars seems to have been written. His description of the stars is founded on Ptolemy's, but an inspection of the work makes it evident that all the stars were re-examined by him with attention. Dr. Schjellerup has given, in the introduction to his work, a comparative table of the magnitudes of the principal stars extracted from Ptolemy, Al Sufi, and Argelander. The table will, no doubt, be found useful where the larger stars are suspected of variability.

The report also contains a review of the reduction of the observations of the transit of Venus, and a report on some of the work which has been accomplished in solar physics during the past year, special reference being made to the delineation of solar prominences by Padre Secchi and Prof. Tacchini. The general result appears to be that the number of prominences has decreased with the decrease in the number of spots, and that great eruptions of metallic vapours have altogether ceased.

The distribution of the prominences has changed greatly in the

last few years; the two maxima which formerly existed at the north and south poles have now disappeared, leaving only the two maxima about latitudes 20° north and south, which have persisted throughout. Prominences of great height or breadth are rare, though the mean height has not much diminished. The wreaths of faculæ, formerly found near the poles, have disappeared with the prominences, implying a connection between them rather than with the spots. Reference is also made to Mr. Langley's paper on the structure of the photosphere and to his beautiful drawing of a typical sun-spot, given in the *American Journal of Science*, and reproduced in these columns. Mr. Langley has also given in the *Comptes Rendus* the results of his investigation of the relative temperatures of different parts of the sun's surface. He has employed a refracting telescope of 13-in. aperture, and has enlarged the focal image of the sun to a circle of two feet. He has made use of a delicate thermopile, composed of 16 pairs of very small elements, and has, in the course of his experiments, tested Padre Secchi's statements as to the comparative heat derived from the sun's limb, and from the apparent centre of the disc, and as to the equatorial regions being hotter than the polar.

Professor Mayer has invented a method for registering isothermals on the sun's disc, depending on the fact that the double iodide of copper and mercury becomes darker at a temperature of 70° C. The blackened surface of a sheet of thin paper, coated with the iodide on the back, is exposed to the image of the sun formed in the telescope, and the different isothermals are obtained by using different areas of the object-glass. Professor Meyer concludes that there exists upon the sun areas of sensible uniform temperature which are continually changing their positions.

Besides the above subjects, the report also contains a long account of the progress of meteoric astronomy during the last year, as well as the usual reports from the public and private observatories.

The report having been read, the President commenced his address upon the presentation of the gold medal of the Society to M. Leverrier. It had been hoped that the distinguished French astronomer would have been present at the meeting, but it appeared that when M. Leverrier expressed his intention to be present, he was under the impression that the meeting would not take place before May, and he wrote to say that he was unable to attend at this season of the year. It is impossible to give an abstract of the President's address, which consisted of an historical account of the investigations of M. Leverrier, and of the important physical results to which he had been led, amongst

which was the prediction of a necessary alteration in our estimate of the sun's distance.

The gold medal having been handed to Dr. Huggins as foreign secretary,

The President said: You will transmit this medal to M. Leverrier and express to him the interest with which we have followed his unwearied researches, and the admiration we feel for the skill and perseverance by which he has succeeded in binding all the principal planets of our system, from Mercury to Neptune, in the chains of his analysis. You can tell him how sorry we are not to have him amongst us on the present occasion, and how glad we shall be to welcome him if he is able to visit us later in the session. We hope that he will then have finished the printing of his tables of Saturn and his theory of Neptune, and thus be able to rest awhile and to re-establish his health, until he goes forth again with fresh vigour to win new triumphs in the fields of Physical Astronomy. (Applause.)

Admiral Ommanney: Gentlemen, I have a resolution to submit for your acceptance. You have all heard the report read. It is pleasing to find there is evidence of increased vitality and energy in the work of our Society, and that the investments have increased as well as the number of members. I think under these circumstances we may congratulate ourselves on being in an improving state, and I think we may congratulate the Council in having selected such an illustrious man as M. Leverrier as the medallist of the year. With these observations, I trust you will agree with me that the report has met with your approval and satisfaction. With regard to the address which you have heard from the President to-day, it is quite impossible for me to express in sufficiently laudable terms what I think of it, and what I am sure you would wish to convey to him. I am quite sure you all appreciate it in the way that I do. It is one of those productions which I am sure will redound to the honour of the Society, and will be a lasting record amongst those valuable productions for which we are so deeply obliged to our President, and which have established his fame and character as one of the greatest astronomers of the age. With these few remarks, knowing how well you appreciate and value all the research which he has just exhibited to us, and which no man could have more ably than our worthy President, I beg to move this resolution: "That the report now read be received and adopted, and that it be printed and circulated in the usual manner, together with the President's address."

Mr. Brewin: I have great pleasure in seconding the motion before the meeting. The report, as Admiral Ommanney says,

shows that much has been done for the Society in business matters during the past year. In a society like this, science, of course, claims our principal attention, but if attention is not also paid to business matters no society can flourish. I am particularly glad to find that the arrears have been so well worked up.

The Astronomer-Royal: The remarks which I have to offer to the Society will not bear on the Council's report, but I think it would be wrong in a person who, like myself, has through a long series of years given some attention to the subjects which have established M. Leverrier's claim to the medal, did I omit to say on the present occasion that the address in which the President has explained the nature of those claims is, I think, something unequalled in the history of our science. (Applause.) Considering the remarkably complicated circumstances to which M. Leverrier's theory applies, I cannot conceive a more admirable analysis than has been given in the President's address. I thought it my duty to say this on the present occasion. With regard to the motion which has been made, I have nothing further to say than that I give it my cordial support.

The motion was carried.

The President: I beg to say how much I appreciate the manner in which my address has been received, and in particular to acknowledge the remarks of the Astronomer-Royal, although I feel that they are expressed in much too flattering terms.

Mr. Lynn: Our distinguished President stated when he began his address that he had a pleasing duty to perform. I also have a pleasing duty imposed upon me, and though a much easier one than his, I think I may claim a certain measure of importance for it. When we have received valuable and acceptable benefits, it is surely both an important and pleasing duty to return our thanks to those who have given us those benefits, and therefore without more words, as the hour is getting on, I beg to move that the thanks of the Society be given to the President, the Vice-Presidents, Secretaries, and members of the Council generally who now retire, for their services in promoting the objects of the Society.

Mr. Knobel: I have great pleasure in seconding that resolution.

Mr. G. F. Chambers: Before that motion is put, I should like, as one who uses the library, to express my strong satisfaction at the improvements carried out during the past year in connection with the library of the Society. No one who has had any occasion to refer to that library can fail to see that an enormous amount of painstaking labour has been undertaken by somebody, and I think it devolves upon us to testify our special thanks for what has been done in reorganizing and making the library acceptable to the

Fellows at large. I may state in addition that I would suggest that during the coming year some steps be taken to utilize the large stock of old *memoirs* which are stored away upstairs, by selling them to the Fellows at a reduced price. There is a large stock accumulated which is rotting away, whereas if they were distributed amongst the general body, it might not only be advantageous to the Fellows, but to the science of astronomy generally.

Mr. Drach: Another proposal I would submit to the Society is, whether the balance of the Turnor fund might not be available for binding several of the old books and quarto memoirs. There are two or three I have given to the Society which have not yet been bound.

Mr. Ranyard: Mr. Drach has, I know, given a great many valuable books to the library. I am glad to say that the rebinding has been going on very actively during the past year. A sum of £50 has been voted by the Council for the purpose, and that sum is now nearly all expended. The Turnor fund, according to the terms of the bequest by which it was left to us, was for the purchase of books, of which we have great need, for our library. Money for binding, of which there is still great need, must come from the general funds of the Society.

Mr. Dunkin: We are obliged, by the terms of the bequest, to purchase books, and not spend the money in binding.

The resolution was put and carried.

Dr. Pinches, referring to the missing instruments which had been given to the observatory at Melbourne, asked if they had been satisfactorily accounted for.

The President: That matter has been all set right.

Admiral Ommanney and Mr. Lynn were appointed scrutineers for the ballot for officers. The ballot having taken place, it was announced that the following Fellows of the Society had been elected:

President.

Dr. W. Huggins.

Vice-Presidents.

Professor Adams. Mr. W. De la Rue.
Sir G. B. Airy. Mr. Lassell.

Treasurer.

Mr. Whitbread.

Secretaries.

Messrs. Dunkin and Ranyard.

Foreign Secretary.

Lord Lindsay.

Council.

Captain Abney.
Mr. Brett.
Prof. Cayley.
Mr. Christie.
Mr. Glaisher.
Mr. Knobel.
Mr. Knott.
Captain Noble.
Rev. S. J. Perry.
Prof. Pritchard.
Earl of Rosse.
Captain Tupman.

The President: The business of the meeting being now concluded, it only remains for me to thank you, in retiring from this chair, for the support which I have always received from the officers and members of the Society during my term of office, and to express the great satisfaction with which I have witnessed the prosperity of the Society, both in its financial and its scientific condition, and I also wish to express the great gratification I feel in giving up this chair to so distinguished an occupant as Dr. Huggins. (Applause.)

LOAN EXHIBITION OF SCIENTIFIC APPARATUS.

We are glad to see, from the following report in the *Standard* of Friday the 25th, that the long-promised exhibition of scientific apparatus is likely to be so complete and interesting. It is earnestly to be wished that a complete and descriptive catalogue will be ready by the opening day, or very much of the utility of the exhibition will be lost. It will be better to postpone the opening than, as on some previous occasions, to open before the catalogue is prepared.

A meeting of the committee for the Loan Exhibition of English and Foreign Scientific Apparatus, which the Committee of Council on Education have decided to hold at South Kensington, during the present year, took place yesterday at the Science Schools, South Kensington. The Duke of Richmond and Gordon presided, and amongst the members of the general committee present were Lord Sandon, Sir Henry Cole, K.C.B., Professor Huxley, Dr. Hooker, President of the Royal Society; Professor Goodeve, Dr. G. J. Allman, President of the Linnæan Society; Dr. Mann, President of the Meteorological Society; Professor Ramsay, Vice-Admiral Sir R. Collinson, K.C.B., Professor Acland, Professor Frankland, Professor Shelley, Mr. N. Story Maskelyne, F.R.S., and Mr. Scott Russell, F.R.S.

The proposed exhibition is intended to consist of instruments and apparatus employed for research and for other scientific purposes, and for teaching. It will also include apparatus illustrative of the progress of science, and its application to the arts, as well as such as may possess special interest on account of the

persons by whom, or the investigations in which, it had been employed; models, drawings, or photographs will also be admissible where the originals cannot be sent. The exhibition will open on the 1st of April, and will remain open until the end of September, after which time the objects will be returned to the owners.

The Duke of Richmond, in opening the business, said twelve months had expired since they first met to put in motion the plan for holding a scientific exhibition, and he was happy to congratulate them upon the success which had attended their efforts to bring about that which promised to be one of the most interesting exhibitions yet held in this country. He could not refrain from tendering the thanks of Her Majesty's government to the gentlemen whose exertions had contributed so much to the attainment of that success. It was also very gratifying to find that their proposals had met with much favour and many offers of co-operation in all parts of the Continent. During the winter the various sub-committees, appointed at the general meeting in June last, had held several meetings to forward the preliminary arrangements for the exhibition. Reports were made of the results of visits to foreign countries by officers of the department, and various suggestions offered had been acted upon with a view of obtaining interesting objects for exhibition. Gentlemen had also been employed to visit the leading provincial towns, with the best results. The importance of the co-operation of foreign governments was represented to the respective ministers through the Foreign Office, and in response to the appeal the governments of Belgium, France, Germany, the Netherlands, Italy and Switzerland had appointed committees to act in concert with the general committee in London. Russia intended to contribute an interesting collection from the Pedagogical Museum, and the Russian Academy had formed a committee under Professor Strüve. The Austrian Minister of Instruction had taken the matter in hand for that country, and one of his officers was in correspondence with the Science and Art Department. He (the noble chairman) mentioned these particulars to show the great interest taken in the exhibition on the continent. The appeals made at home to government departments, the learned societies and men of science, were generally well received. The Admiralty undertook to contribute a complete scientific outfit of a surveying ship and dredging apparatus; the Post Office as complete a historical collection of telegraphic apparatus as existed, and they also proposed to communicate Greenwich time, and fire a time gun to illustrate their method of communicating time throughout the country. The Trinity House, Ordnance Survey, Royal Observatory, and Geologi-

cal Survey likewise promised contributions. From the War and India Offices no replies had yet been received, but he understood they were taking steps to contribute several objects of interest, particularly from Woolwich Arsenal. The Royal Society, the Royal Institution, the Astronomical, Geographical, Microscopical, and Horological Societies were all willing to co-operate and send collections for exhibition, and King's College promised to lend the apparatus of the late Sir C. Wheatstone. From a number of institutions in the provinces and several noblemen and gentlemen assistance might also be expected, and with the specimens of their apparatus which would be shown by the instrument makers he thought there was every prospect of a fairly representative exhibition. A committee were forming a most interesting collection illustrative of the scientific principles on which the construction of musical instruments were based; Mr. Markham would furnish a set of Arctic maps; Mr. H. Galton, a collection of explanatory apparatus; Mr. Scott, of the Meteorological Office, some of his apparatus; and Dr. Mann, instruments connected with atmospheric electricity. Among the exhibits from Germany, they were led to expect some of Tycho Brahe's instruments, and the original air-pump of Otto von Guericke. From France there was as yet no definite information, but they hoped to receive some interesting objects, as the French commission had devoted considerable attention to the matter, and the Conservatoire des Arts et Metiers promised some of their finest things. From Italy they anticipated obtaining a portion of the instruments used by Galileo, Torricelli, Volta, and Galvani. It was intended originally to hold the exhibition in the galleries of the South Kensington Museum, but it had since been found necessary, from want of room and other considerations, to make fresh arrangements, and so they had decided it should take place in the western galleries of the building lately used for the annual International Exhibitions. Various learned societies had been invited to organise conferences and *conversaziones*. It would be for the committee to consider the advisability of forming sub-committees to carry on the arrangements after the opening of the exhibition, to organise receptions, and so on. In his opinion such work would be better done by a small body of gentlemen than by a large one, but he would be pleased to receive any suggestions on the subject.

Dr. Hooker thought they could not do better than nominate a sub-committee to take under its control conferences, the reading of papers, and the arrangement of receptions to distinguished foreign visitors.

After a brief conversation, taken part in by Lord Sandon, Professor Ramsay, Professor Shelley, Mr. Scott Russell, and other

gentlemen, the suggestion was embodied in a resolution, and adopted with the understanding that the sub-committee was to consist of the president and one vice-president of each of the learned societies. The noble Chairman having promised the cordial co-operation of the general committee, the proceedings terminated.

With respect to the Royal Astronomical Society, the Council at their last meeting offered to the Commissioners anything in the possession of the Society which they might consider suitable for the exhibition. Among the objects chosen are Bailey's apparatus which he used in his Cavendish experiments, and the "Herschelian" telescope.

REVIEWS.

Etudes et Lectures sur l'Astronomie. Par Camille Flammarion. Tome sixième, accompagné de 27 figures astronomiques. Paris. Gauthier-Villars, 1875. [D. Nutt, 270, Strand. 2s. 6d.]

This volume is entirely devoted to sidereal astronomy. Amongst other subjects treated of are—the proper motions of the stars ; spectrum analysis, leading to the determination of the stars which are receding from or approaching the earth, and of their rate of motion ; relation between the movement in space of the sun and that of Sirius ; aberration and velocity of light considered in their relations with the movement of translation of the solar system ; precession of the equinoxes ; a new, easier, and more accurate method of determining the orbits of double stars ; the same applied to various double stars, 70 Ophiuchi, γ Virginis, ξ Ursæ Majoris, ζ Herculis, η Coronæ, 61 Cygni. This last proves to be, not a real binary star as to orbital movement, but a particular system of two stars physically associated in "a common proper motion," and both moving in a straight line. Other groups, to which the author applies the designation of "perspective," are also discussed, being double or multiple stars, formed of bodies casually associated by celestial perspective, which change their relative places, moving in a right line, by reason of diversity of proper motions. In an appendix we are presented with the author's meteorological observations, made in various balloon ascents, which are of considerable interest. Altogether this volume is of much value, and should be read by all who are specially concerned with the sidereal department of our science. M. Flammarion is about to publish a special work on the orbits of double stars. He states that the seventh volume of the present series will contain the observations of the transit of Venus, and the results as to the sun's parallax, and volume eight is to be entirely devoted to planetary astronomy.

It is superfluous now to praise the ability of this French astronomer, his valuable investigations, and his lucid and agreeable manner of writing. He displays no personal or national jealousies, and his frequent mention of fellow-labourers of all countries is cordial as well as just.

The Peers of the earth—the solar system, is the title of a paper in the *Marble Arch* for February, by Mr. Richard Sheward, whose speculations have before been noticed in the *Astronomical Register.* Our earth is in full career with accelerated motion in a straight line to make a capture of α Centauri, which will then revolve around it, to the immense benefit of

the earth and all the other planets. In fact this will bring about the promised millennium, which, however, (and Dr. Cumming and others should see to this) cannot be inaugurated for 1,500 years to come *at the least*. Mr. Sheward seems to be a man of piety, and therefore to be respected, but it appears to us that even if we were to concede to him that we are going at the rate of 17,600 miles per hour (which he says will be 20,000 before another century) in a precisely known rectilinear direction, the problem of the final consequences might well embarass Leverrier or Adams. And even with Mr. S. for engine-driver we cannot but feel rather nervous. Indeed, by his own showing (p. 292), the rushing suns only "just escape collision at the junction." The analogy between the sun's rule of the planets and human governments is not badly drawn in this paper.

Mémoire sur les occultations d'étoiles par les planètes. Par J. A. Normand. Paris: Gauthier-Villars. 1876. pp. 20.

M. Norman is sanguine about the occultations of stars by planets—especially by Mars at opposition—proving the best way of all others for determining the absolute dimensions of the solar system, and the diameters of the planets. He shows that these phenomena are sufficiently frequent. Thus, at the opposition of Mars in 1875, the number of possible occultations was 9¼ in 24 hours. (In 1877, the possible number is only 0·8.) He gives formulæ from Bessel for the calculation of occultations for any given point on the earth, and applies them to two instances. 1. The occultation of 3 Sagittarii (5th mag.) by Mars, June 29th, 1875. As this could only have been seen in high southern latitudes, the computation is made for Sandwich Island and Chatham Island. The middle of the phenomenon is found to have occurred 28m. 22s. later at Chatham Island than at Sandwich. The distance between the supposed places of observation is here small, and the observations would not, therefore, have been favourable for the determination of the parallax. 2. The occultation of the star 1448 of Lamont's catalogue (7-8 mag.) by Jupiter, March 10th, 1875. Computations made for Paris, St. Petersburgh, and the Cape of Good Hope observatory, give the difference of duration between the two northern stations and the southern one about 20 seconds. M. Normand remarks that whilst Mars is the only planet suitable for parallax observations in the way he proposes, yet the other superior planets, as Jupiter and Saturn, are well adapted for the measurements of their diameters. He goes into calculations of the relative goodness of the various observational methods of determining parallax, and allowing that his figures are undoubtedly *excessively* hypothetical, nevertheless contends for the superiority of the system he proposes. If it should be thought worthy of being put to actual proof, he advises the preparation of a complete catalogue of stars comprised in the trajectory of Mars during the opposition of 1877 (about ¾ hour of R.A. and 3° of Decl.) Although the occultations will be few, they will have an exceptional value by reason of the small distance of Mars.

There are many whose familiarity with first-class instruments (and probably only such could be usefully employed) would enable them to give a better opinion than ours on this subject. We will only say that M. Norman appears to us to have shown that it is desirable that such observations should be attempted. It is probably not likely that expeditions would be sent out on purpose, and therefore we should have to look for concerted action between established observatories at great distances from each other.

THE LAW OF GRAVITATION.

Force, ascertained according to some measure of its operation—this is indeed one of the definitions, but only one, of a scientific law. The discovery of laws in this sense is the great quest of science, and the finding of them is one of her great rewards. Such laws yield to the human mind a peculiar delight, from the satisfaction they afford to those special faculties whose function it is to recognise the beauty of numerical relations. This satisfaction is so great, and in its own measure is so complete, that the mind reposes on an ascertained law of this kind as on an ultimate truth. And ultimate it is as regards the particular faculties which are concerned in this kind of search. When we have observed our facts, and when we have summed up our figures, when we have recognised the constant numbers,—then our eyes, our ears, and our calculating faculties have done their work. But other faculties are called into simultaneous operation, and these have other work to do. For let it be observed that laws, in the first three senses we have now examined, cannot be said to explain anything except the order of subordinate phænomena. They set forth that order as due to force. They do nothing more. Least of all do laws, in any of these three senses, explain themselves. They suggest a thousand questions much more curious than the questions which they solve. The very beauty and simplicity of some laws is their deepest mystery. What can their source be ? How is their uniformity maintained ? Every law implied a Force, and all that we ever know is some numerical rule or measure according to which some unknown forces operate. But whence came these measures—these exact relations to number, which never vary ? Or, if there are variations, how comes it that these are always found to follow some other rules as exact and as invariable as the first ?

And as there can be no better example of what law is, so also there can be no better example of what it is not, than the law of gravitation. The discovery of it was probably the highest exercise of pure intellect through which the human mind has found its way. It is the most universal physical law which is known to us ; for it prevails, apparently, through all space. Yet of the force of gravitation all we know is, that it is a force of attraction operating between all the particles of matter in the exact measure which was ascertained by Newton,—that is—" directly as the mass, and inversely as the square of the distance." This is the law. But it affords no sort of explanation of itself. What is the cause of this force—what is its source—what are the media of its operation—how is the exact uniformity of its proportions maintained ?—these are questions which it is impossible not to ask, but which it is quite as impossible to answer. Sir John Herschel, in speaking of this force, has indicated in a passing sentence a few questions out of the many which arise :—" No matter," he says, " from what ultimate causes the power called gravitation originates—be it a virtue lodged in the sun as its receptacle, or be it pressure from without, or the resultant of many pressures, or solicitations of unknown kinds, magnetic or electric, ethers or impulses,* &c., &c. How little we have ascertained in this law, after all ! Yet there is an immense and an instinctive pleasure in the contemplation of it. To analyse this pleasure is as difficult as to analyse the pleasure which the eye takes in beauty of form, or the pleasure which the ear takes in the harmonies of sound. And this pleasure is inexhaustible, for these laws of number and proportion pervade all nature, and the

* Herschel's " Outlines of Astronomy," Fifth Edition, p. 323.

intellectual organs which have been fitted to the knowledge of them have eyes which are never satisfied with seeing, and ears which are never full of hearing. The agitation which overpowered Sir Isaac Newton as the law of gravitation was rising to his view in the light of vigorous demonstration, was the homage rendered by the great faculties of his nature to a harmony which was as new as it was immense and wonderful. The same pleasure in its own degree is felt by every man of science who, in any branch of physical enquiry, traces and debates any lesser law. And it is perfectly true that such laws are being debated everywhere. Forces which are in their essence and their source utterly mysterious, are always being found to operate under rules which have strict reference to measures of number,—to relations of space and time. The forces which determine chemical combination all work under rules as sharp and definite as the force of gravitation. So do the forces which operate in light, and heat, and sound. So do those which exert their energies in magnetism and electricity. All the operations of nature—the smallest and the greatest—are performed under similar measures and restraints. Not even a drop of water can be formed except under rules which determine its weight, its volume, and its shape, with exact reference to the density of the fluid, to the structure of the surface on which it may be formed, and to the pressure of the surrounding atmosphere. Then that pressure is itself exercised under vigorous rules again. Not one of the countless varieties of form which prevail in clouds, and which give to the face of heaven such infinite expression, not one of them but is ruled by law,—woven or braided, or torn, or scattered, or gathered up again and folded,—by forces which are free only "within the bounds of law."—*The Reign of Law*, by the Duke of Argyll, pp. 71-75.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

LUNAR NOMENCLATURE.

Sir,—The proposal of Mr. Birt to remove the name Wichmann from the crater Euclides A, of Beer and Mädler to the well-known crater Mösting A, is not, as far as I am concerned, practicable. For some considerable period this name has been standing in the descriptive letterpress, and the maps which are to accompany my forthcoming work upon the Moon ; and no change in these can be effected.

Neither do I think that the proposed change would be advantageous. Mösting A, Murchison A, and Hipparchus C, are the three main points of the investigation of the real physical libration of the moon that I have undertaken and already commenced, and I do not think that any advantage whatever would result by attaching to them any special name. From the relative position of each of these, I think they are not well fitted to receive names which should, in my opinion, be only attached to spots absolutely requiring them.

Alterations in, and extensions of the present nomenclature of the moon must be effected with considerable care, for the mere indiscriminate naming of lunar formations, so far from being any gain to selenography, is a positive disadvantage as rendering the present system unwieldy and unmanageable. More especially care should be taken in the selection of names ; and

very much may be urged in favour of confining these solely to astronomers, practical and theoretical. The cramming into a system of selenographical nomenclature of a heterogeneous medley of astronomers, physicists, divines, statesmen, adventurers, &c., though it has to a certain extent received the sanction of the earlier selenographers, is much to be deprecated, for it can only end in rendering the whole system ridiculous. Those who have devoted their energies and lives to the promotion of astronomy, and more especially to the subject of our satellite, are those whose names should be commemorated by being attached to various formations on the moon. Laplace, Mädler, Schmidt, and Delaunay appear appropriately enough in the present system of lunar nomenclature, can the same be said of Julius Cæsar, John Smith, Cook, and Marco Polo?

The system of nomenclature employed by Mädler does not, however, admit of modification; for use and authority has rendered it the standard system of nomenclature of the moon. No extensive alteration in this, therefore, is admissible, for such could only lead to confusion and be a constant source of puzzling and annoying errors. Though, therefore, the nomenclature employed by Mädler might be improved in some respects by the omission of certain of his names, in practice this would be unjustifiable except in a few minor cases. No other series of names, however, possesses this authority, and can claim the exemption from all amendment; and if any alterations in later additions to the present lunar nomenclature appear to offer any gain of moment, it is not to be questioned that such may be effected without creating any material confusion whatever.

It cannot be too strongly urged that only definite formations should receive names, or in other words, that distinct names should only be given to walled plains, ring plains, craters, and great mountain ranges. Indefinite tracts of surface, more or less partially enclosed portions of hill-lands, mere depressions in the surface, and other equally indefinite objects are not suitable, and much would be gained if names attached to these were struck out of the system of nomenclature.

Attention has been repeatedly drawn to the supposed confusion that exists from the alterations made by Mädler in the system of nomenclature employed by Schröter, and it has been urged that Schröter's names should be restored, and Mädler's removed. This is a subject which does not, however, seriously need debate, for the proposal is now quite indefensible. For can it be urged that any real confusion now exists that can be at all compared with what would arise were this proposal carried into effect. Mädler's map and Mädler's works are now the authority on selenography, and Schröter's works are to all practical purposes effaced. And even were this not so, would it be permissible to substitute Schröter's nomenclature for Mädler's, except in one or two instances, for in almost every case will it appear on impartial examination that the alteration introduced by Mädler is a distinct gain to selenography.

Nor is it to be considered that reference to the numerous plates and elaborately detailed descriptions of Schröter is indispensable to selenographers; for so far from this being necessary, it is rarely that the slightest gain will result. The careful drawings of Schröter in few instances contain any amount of detail, and in perhaps no instance can be compared with the drawings or maps of either Lohrmann or Mädler for completeness. As a general work of reference, the two great volumes of Schröter are practically of slight value to the selenographers of the present day, and it will be seldom indeed that the drawings and descriptions of these works will prove of

any use in aiding observers at the present time in their study of the moon's surface.

There are, it is true, questions where Schröter's drawings are still of importance, namely, with reference to the great mountain ranges of the further lunar hemisphere, &c.; these are, however, distinct from the drawing of the details of the generally visible surface of the moon. For general selenographical purposes, however, Schröter's two volumes of drawings and descriptions have been entirely superseded; and this will be the opinion of all who examine his historically most interesting works, and compare them with the present needs of selenography. Too much cannot be said of the value and importance of Schröter's works in their day; too much praise cannot be accorded to Schröter for his zealous and untiring labours in the cause of selenography; but no alarm need be felt that too little use is now made of these labours, for such is scarcely possible.

In the present condition of lunar nomenclature, the process of augmenting the long catalogue of named formations can easily be carried on too rapidly to be useful. As it is, the five hundred odd names at present in existence are a considerable tax upon the memories of even the most assiduous selenographers, and if they are very materially and quickly increased, it will for most be impracticable to keep the swollen list in memory.

There is another reason why the inordinate increase in the lunar nomenclature is not an unmixed advantage. As long as the system perfected by Beer and Mädler for the designation of the minor details of the lunar surface is retained, the new special naming of any formation introduces much confusion in this subordinate classification. For unless endless confusion is to be introduced, all the detail near this newly named object must assume as a general or generic name that of the new addition to the lunar nomenclature. Therefore, objects that previously fell under the details of the region whose principal object is designated, say, A, B, C, and D, now come under the new generic name W. And the difficulty in deciding what names have been so altered, will be found a difficulty of considerable moment in reference to the earlier selenographers.

In considering, therefore, the fitness of an object to receive a special name of its own, it is in practice not only necessary to examine whether any advantage would be gained in naming the particular formation, but whether it would be fitted in its new capacity to act as a centre of reference for the minor details surrounding it, and whether it could serve this purpose without any serious interruption of the previous system of classification.

It in fact deserves serious attention whether any formation whatever on the moon should be named, unless considerable advantage either in purposes of reference, or in simplification of classification should be gained by so doing. E. NEISON.

S *ORIONIS—DAYLIGHT METEOR.*

Sir,—I shall feel much obliged by the correction of an error which has accidentally crept into your report, of a paper of mine which was read at the last meeting of the Astronimical Society. I am there represented as stating that the variable star S Orionis had decreased to such an extent that at the end of December I could hardly detect it. Such was by no means the case; though greatly diminished, it is still very conspicuous with my 9.38-inch speculum. I have seen it much smaller on former occasions, and could follow if much further towards, or probably through, its minimum.

With respect to the curious meteor in daylight of Dec. 22nd, 1875, described by me in *Nature*, Jan. 6, Mr. Denning is quite correct in supposing that the time, which was given to me by my servants, was merely approximate. There can be no doubt of the accuracy of the other observers, or of the identity of the meteors.

T. W. WEBB

Hardwick Vicarage:
Feb. 8. 1876.

OBSERVING NIGHTS.

Sir,—Perhaps the subjoined figures, showing the opportunities for observing presented to northern observers during the year 1875, will not surprise many of your readers. They may give a little comfort to some, who, on looking over their note-books for the year just passed, feel disposed to blame themselves for want of industry.

Yours very truly,
JOSEPH GLEDHILL, F.R.A.S.

Bermerside Observatory, Halifax:
Feb. 13th, 1876.

OBSERVING NIGHTS IN 1875.

	Very Fine	Good	Fair	Bad	Clear all night.
Jan.	0	0	0	1	1
Feb.	0	0	0	3	2
Mch.	0	0	2	3	2
April	2	0	0	4	5
May	0	1	4	4	4
June	0	2	4	0	5
July	0	2	5	0	5
Aug.	0	2	3	1	5
Sept.	0	2	3	0	2
Oct.	0	0	1	1	1
Nov.	0	0	0	2	2
Dec.	0	0	0	2	1
Total	2	9	22	21	35
1874	8		45	42	44

HALOS, &c., IN 1875.

The following summary of the number of time halos (lunar and solar), lunar coronæ, and the zodiacal light, were observed here in 1875, are here offered for the sake of comparison with the observations which may have been made in other parts of England. All were observed between 9 a.m. and midnight. On such nights as the moon rose after midnight, the appearance of halos or coronæ would rarely be noted. With regard to the zodiacal light, the observations refer to its appearance after sunset, no look-out being kept for morning exhibitions.

Not a single aurora was seen here during the year, although on every clear evening and night the north-western sky was carefully examined at times up to at least midnight. Even a faint auroral flow could hardly have been overlooked.

1875.		Coronæ.		Halos.		Zodiacal light
January	...	4	...	6	...	1
February	...	2	...	3	...	1
March	...	—	...	3	...	3
April	...	—	...	4	...	—
May	...	—	...	2	...	—
June	...	—	...	2	...	—
July	...	—	...	4	...	—
August	...	—	...	—	...	—
September	...	—	...	3	...	—
October	...	—	...	2	...	—
November	...	—	...	2	...	—
December	...	1	...	—	...	—
		7	...	31	...	5

TRANSIT OF VENUS.

Sir,—Owing I believe to an accident, I did not receive the proof of my remarks at the last meeting of the Astronomical Society in time for correction. As your reporter's account does not very correctly represent what I wished to say, I shall be obliged if you will insert the following amended paragraph :—

"As to the visibility of the planet outside the sun, I may state that at Rodriguez, the portion of the planet outside the sun's limb was distinctly seen by me with an ordinary 2-in. telescope, bearing a power of 30, about fifteen minutes before first internal contact of limbs. With reference to the relative sharpness of the planet and the model, I can only say that the photographs of the former fall decidedly below those of the latter and other terrestrial objects in respect of definition, showing plainly in many cases the presence of an atmosphere about the planet."

I am, sir, your obedient servant,

C. E. BURTON.

LUNAR OBJECTS SUITABLE FOR OBSERVATION IN MARCH, 1876.

By W. R. Birt, F.R.A.S., F.M.S.

It is greatly to be desired that the possessors of larger telescopes would turn them upon the moon, not simply for gazing purposes, but to add to our knowledge of our satellite, although of late years many *minute* lunar objects have been described, several of them require confirmation ; and as in our last list we revised in some measure Zone II. of the the British Association map, it may probably assist in furthering the purposes for which the map was projected, if we notice some of the objects, principally craters, indicated in this map on a portion of Zone II. designated IV. A β S. latitude (0° to 5°) W longitude (5° to 10°). The report to the British Association 1868, entitled "Mapping the Surface of the Moon," p. 14, contains a list of 15 craters, on these 26 square degrees varying in magnitude from 0·16 to 1·17, the diameter of Dionysius being regarded as 1·00. The magnitudes have all been determined by measurement either with the micrometer or on Rutherfurd's photogram, March 6, 1865. There are two reasons why these 15 craters should be re-examined. *First* the magnitudes are given for an epoch of about 11 years preceding

the present. As all but one of these objects are smaller than Dionysius and five less than a fifth of that crater, it is possible that changes may have taken place in some of them. *Second.* It would be very desirable to ascertain if they are all *now in existence.* Dr. Newmann, of Dresden, in his Progress of Astronomy during the last ten years, states that "of our *moon* it is noticeable that according to numerous observations, there is still volcanic activity in it"; and in connection with this statement, we may remark that these 15 craters were certainly in existence in 1865, and can actually be seen on the photogram of March 6, of that year, and this leads to the remark that one of the most efficient means of studying selenography is to carefully examine photograms; the appearance of objects at the epoch of any given photogram can for that epoch be most carefully determined *at leisure,* telescopic observation is evanescent, photographic permanent.

The positions of the objects hereafter to be specified will be indicated by the square degree in which they occur, and the objects themselves by the number of the area IV. A β as they stand in the report, an asterisk signifies that the object is easy of observation.

In the square degree 3° to 4° south latitude 9° to 10° west longitude are three objects, 83*, 84, and 85; the first 83 is described as "a raised and nearly filled ring," its length is nearly 10", breadth 7".64; it is distinct on Rutherfurd, but although an easy object, it may readily be overlooked in telescopic observation, and this may account for its absence in Lohrmann's and Beer and Mädler's maps: 84 is described as "an elliptical crater," length 6."25, breadth 3."17, magnitude 0·28, it adjoins 83 on the east; 85 a craterlet north of 84, length 3"·54, breadth 3"·17, magnitude 0·20. These three objects forming the apex of a nearly isosceles triangle with the two northern of the three conspicuous craters west of Halley and Horrox IV. A 72, IV. A, β 19, IV. A, β 14, may be found by drawing a line W. by N. from Horrox nearly midway between IV. A β 19 and IV. A β 14.

It is gratifying to find in the present paucity of physical observations of the moon that now and again drawings of special portions of the surface come to hand. I have to acknowledge receipts of one of Gassendi by Mr. David Simms, of Thurso, Canada; it contains nine craterlets, four mountains including the central peaks, and *one* cleft. The best published account of Gassendi, by Mr. Neison, will be found in the *Astronomical Register*, Vol. XI. pp. 124-197 and 249, which we strongly recommend for careful study.

THE MINOR PLANETS JUNO AND VESTA.

The Minor Planet Juno (No. 3 of the series) will come into opposition on the 27th of the month.

	Right Ascension.					Declination.		
	h.	m.	s.			°	′	″
March 1	12	54	39	...	S.	1	29	50
15	12	45	41	...	N.	0	27	56
27	12	36	26	...	N.	2	13	21

The Minor Planet Vesta (No. 4 of the series) will come into opposition on the 28th.

	Right Ascension.					Declination.		
	h.	m.	s.			°	′	″
March 1	13	10	25	...	N.	4	56	23
15	13	2	48	...	N.	6	39	41
28	12	52	3	...	N.	8	14	10

ASTRONOMICAL OCCURRENCES FOR MARCH, 1876.

DATE.			Principal Occurrences.	Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Regulus —
Wed	1		Sidereal Time at Mean Noon, 22h. 38m. 31·50s.	2nd Sh. I. 2nd Tr. I. 2nd Sh. E. 2nd Tr. E.	13 34 16 0 16 7 18 32	11 21·4
Thur	2	21 47 11 30	☽ Moon's First Quarter Near approach of χ^1 Tauri (5¾) Sun's Meridian Passage 12m. 14·74s. after Mean Noon			11 17·5
Fri	3	8 54 10 2 14 46	Occultation of B.A.C. 1648 (6½) Reappearance of ditto Occultation of B.A.C. 1746 (6½)	3rd Sh. I.	17 41	11 13·5
Sat	4	11 2 11 29 13 13	Occultation of B.A.C. 2097 (6½) Reappearance of ditto Near approach of 49 Aurigæ (5½)			11 9·6
Sun	5	15 10	Near approach of *c* Geminorum (6)			11 5·7
Mon	6	14 43 15 19	Occultation of γ Cancri (4½) Reappearance of ditto	1st Sh. I. 1st Tr. I.	16 27 17 40	11 1·7
Tues	7			3rd Oc. D. 1st Ec. D. 3rd Oc. R. 1st Oc. R.	12 54 13 47 37 14 27 17 9	10 57·8
Wed	8			1st Sh. E. 1st Tr. E. 1st Sh. I.	13 8 14 19 16 9	10 53·9
Thur	9	18 12	○ Full Moon Eclipse of the Moon visible at Greenwich			10 49·9
Fri	10			2nd Oc. R.	15 20	10 46·0
Sat	11					10 42·1
Sun	12					10 38·1
Mon	13					10 34·2
Tues	14		Sidereal Time at Mean Noon 23h. 29m. 46·71s.	3rd Ec. R. 1st Ec. D. 3rd Oc. D. 3rd Oc. R.	13 36 5 15 41 4 16 41 18 12	10 30·3
Wed	15	12	Conjunction of Moon and Jupiter, 5° 55′ N. Illuminated portion of disc of Venus=0·730 Illuminated portion of disc of Mars=0·941	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	12 48 13 57 15 1 16 9	Moon. — 4 9·7

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. Moon.
Thur	16		Saturn's Ring: Major axis=35″·08 Minor axis=5″·30	1st Oc. R.	13 27	4 59·4
Fri	17	13 24 15 12 16 33 23	☾ Moon's Last Quarter Occultation of B.A.C. 6107 (4) Reappearance of ditto Conjunction of Saturn and Mercury 0° 24′ S.	2nd Ec. D. 2nd Oc. R.	13 2 52 17 47	5 50·5
Sat	18		Sun's Meridian Passage 8m. 2·94s. after Mean Noon			6 42·3
Sun	19	18 2	Near approach of ω Sagittarii (5)	2nd Tr. E.	12 47	7 33·6
Mon	20					8 23·5
Tues	21			3rd Ec. D. 3rd Ec. R. 1st Ec. D.	15 53 56 17 34 15 17 34 32	9 11·5
Wed	22	17 59 20	Occultation reappearance of 50 Aquarii (6) Conjunction of Moon and Saturn 1° 5′ N.	1st Sh. I. 1st Tr. I. 1st Sh. E.	14 41 15 46 16 54	9 57·7
Thur	23	9	Conjunction of Moon and Mercury 0° 27′ S.	1st Ec. D. 1st Oc. R.	12 2 56 15 16	10 42·6
Fri	24			1st Tr. E. 2nd Ec. D.	12 25 15 36 12	11 27·1
Sat	25	8 11	● New Moon Eclipse of the Sun, invisible at Greenwich	3rd Tr. E.	11 28	12 12·3
Sun	26			2nd Tr. I. 2nd Sh. E. 2nd Tr. E.	12 41 13 11 15 13	Regulus — 9 43·0
Mon	27					9 39·1
Tues	28	7 3 7 54 15 16	Occultation of 47 Arietis (6) Reappearance of ditto Conjunction of Moon and Venus 2° 34′ S. Conjunction of Moon and Mars 3° 43′ S.			9 35·2
Wed	29	9	Conjunction of Mars and Mercury 1° 9′ N.	1st Sh. I. 1st Tr. I.	16 35 17 34	9 31·2
Thur	30			1st Ec. D. 1st Oc. R.	13 56 27 17 5	9 27·3
Fri	31			1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	11 3 12 1 13 15 14 12	9 23·4
APRIL Sat	1	7 33 7 59	Occultation of 47 Geminorum (6) Reappearance of ditto	3rd Sh. E. 1st Oc. R. 3rd Tr. I. 3rd Tr. E.	11 27 11 32 13 35 15 2	9 19·4

THE PLANETS FOR MARCH.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	21 14 49	S. 15 10	8″·2	22 32·6
	9th	21 41 15	S. 14 37	7″·2	22 27·5
	17th	22 18 18	S. 12 25	6″·4	22 33·0
	25th	23 1 24	S. 8 45½	5″·8	22 44·5
Venus ...	1st	1 9 15	N. 7 21	14″·0	2 30·3
	9th	1 44 20	N. 11 19	14″·6	2 33·9
	17th	2 19 51	N. 15 0	15″·4	2 37·8
	25th	2 55 58	N. 18 19½	16″·2	2 42·4
Jupiter ...	1st	15 58 53	S. 19 30	36″·2	17 17·5
	9th	16 0 5	S. 19 32½	36″8	16 47·3
	17th	16 0 29	S. 19 32½	37″.8	16 16·2
	25th	16 0 3	S. 19 30½	38″6	15 44·3
Uranus ...	1st	9 18 42	N. 16 27½	4″·2	10 38·4
	17th	9 16 31	N. 16 37	4″·2	9 33·3

Mercury may be observed for an hour before the sun at the beginning of the month, the interval decreasing.

Venus is a conspicuous object for three hours and a half after the sun on the 1st, the interval increasing to four hours and a quarter by the last day.

Jupiter rises on the 1st one hour after midnight, and on the last day one hour before midnight.

PLANET DISCOVERED BY M. PAUL HENRY.

From *Astronomische Nachrichten*, No. 2,075.
Bulletin International, No. 27.
1876, 26 January, 9h. M. T. R. A. 3h. 16m. 40s. D. +11° 30′.
Diurnal motion +28s. +6′ Mag. 12·5.

PARTIAL ECLIPSE OF THE MOON.

Visible at Greenwich, March 9, 1876.

	G. M. T. h. m.
First contact with the penumbra, March 9	15 56·8
First contact with the shadow	17 21·2
Middle of the eclipse	18 21·2
Last contact with the shadow	19 21·2
Last contact with the penumbra ...	20 45·6

Magnitude of the eclipse, 0·295

The first shadow will take place at 170° from the northernmost point of the moon's limb towards the east.

The last contact at 118° towards the west. In each case for direct vision.

Errata in February number.—P. 36, line 22 from top, for *abroad* read *spread abroad*. Line 4 from bottom, for *south* read *second*. Page 37, line 3 from bottom, for *every day* read *every way*. Page 38, line 21 from bottom, for *suggested* read *supported*.

EPHEMERIS FOR PHYSICAL OBSERVATIONS OF JUPITER.

Greenwich. Midnight. 1876.	Longitude of ♃'s central merid. °	°	Angle of position of ♃'s axis. °	Annual parallax. °	Latitude of earth above ♃'s equator. °	Latitude of sun above ♃'s equator. °
March 1	124·1	870·6	11·76	10·41	—3·16	—3·05
2	274·7	·7	11·74	10·38		
3	65·4	·6	11·72	10·35		
4	216·0	·6	11·70	10·31		
5	6·6	·7	11·68	—10·27		
6	157·3	·6	11·67	10·23	—3·17	—3·05
7	307·9	·7	11·66	10·19		
8	98·6	·6	11·65	10·14		
9	249·2	·7	11·64	10·09		
10	39·9	·7	11·63	10.03		
11	190 6	·6	11·62	9·97	—3·18	—3·05
12	341·2	·7	11·61	—9·91		
13	131·9	·6	11·61	9·85		
14	282·5	·7	11·61	9·79		
15	73·2	·7	11·61	9·72		
16	223·9	·7	11·60	9·65	—3·19	—3·04
17	14·6	·6	11·60	9·57		
18	165·2	·7	11·60	9·49		
19	315·9	·7	11·60	—9·41		
20	106·6	·7	11·60	9·32		
21	257·3	·7	11·61	9·23	—3·20	—3·04
22	48·0	·6	11·61	9·14		
23	198·6	·7	11·62	9·04		
24	349·3	·7	11·63	8·94		
25	140·0	·7	11·64	8·84		
26	290·7	·7	11·65	8·74	—3·21	—3·04
27	32·2	·7	11·66	—8·63		
28	232·1	·7	11·67	8·52		
29	22·8	·7	11·68	8·41		
30	173·5	·7	11·70	8·29		
31	324·2	870·7	11·72	8·17	—3·22	—3·04
April 1	114 9		11·74	8·05		

A. M.

EPHEMERIS OF THE SATELLITES OF URANUS.

1876. 12h. Gr.	Ariel. pos. °	Ariel. dist. ″	Umbriel. pos. °	Umbriel. dist. ″	Titania. pos. °	Titania. dist. ″	Oberon. pos. °	Oberon. dist. ″
March 1	113	7	206	18	311	19	305	24
2	342	12	156	15	234	21	252	24
3	184	15	30	17	200	32	218	34
4	23	14	341	16	180	33	200	43
5	235	9	215	16	150	23	187	46
6	124	8	166	17	78	17	173	41
7	346	12	41	15	29	29	152	31

8	187	15	350	18	7	34	112	23
9	26	13	227	14	343	27	61	26
10	244	8	174	19	288	17	32	37
11	134	8	55	13	221	24	16	45
—								
12	351	13	358	20	194	34	3	45
13	190	15	244	12	173	31	48	39
14	30	12	181	20	134	19	324	28
15	254	8	74	11	58	20	277	22
16	142	9	4	21	22	32	231	29
17	353	14	266	10	1	33	207	39
18	193	15	187	21	332	24	193	45
—								
19	35	12	99	10	263	17	180	44
20	265	7	10	21	211	28	163	36
21	149	10	292	10	188	34	133	26
22	357	14	193	21	164	28	83	23
23	196	15	124	11	113	17	44	32
24	40	11	16	20	44	24	23	41
25	277	7	314	12	15	33	9	46
—								
26	155	11	199	20	354	31	355	42
27	0	14	143	13	317	20	337	33
28	199	14	23	19	242	19	301	24
29	46	10	330	14	203	31	250	24
30	289	7	207	18	182	33	217	34
31	160	11	156	16	154	24	198	43
April 1	3	15	31	17	88	17	186	45

A. MARTH.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To June, 1874.

Loder, E. G.

To Dec., 1875.

Bonomi, Dr. J.
Green, G. N.
Huggins, Dr. W.
Linwood, Rev. W.
Slater, Jas.

To Feb., 1876.

Adams, S.
Longmaid, W. H.

To March, 1876.

Baron, Rev. J.
Dix, F.
Elliott, R.

To June 1876.

Gooch, Miss
Squire, H.

To Dec., 1876.

Andrews, W.
Baxendell, J.
Bayley, T. S.
Lamb, Dr.
Loddiges, C.
Metford, W. E.
Normand, A.
Parnell, J.
Perry, Rev. S. T.
Warriner, H.
Webb, Rev. S. W.
Williams, G.

TO CORRESPONDENTS.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to JOHN C. JACKSON, at Lower Clapton, London, E.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications, Letters, Articles for insertion, &c., must be sent to the Rev. J. C. JACKSON, *Clarence Road, Clapton, E.*, **not later than the 15th of the Month.**

The Astronomical Register.

No. 160. APRIL. 1876.

HORROCKS' MEMORIAL.

We have been asked to publish a complete list of the subscriptions which have been received for the Horrocks' Memorial Fund. A preliminary list was published in our December number for 1874, but since then several additional subscriptions have come in, bringing up the total of the money received to £89 16s. od. Of this sum £25 have been paid as a fee to the Dean and Chapter of Westminster. The customary fee for permitting a tablet to be erected within the walls of the Abbey is, we are informed, £200. A further sum of One Guinea has been paid by the direction of the Dean and Chapter to their Surveyor, and £25 to the Stone-mason for the block of marble and cutting the scroll and inscription.

The residue of £38 15s. od. has been paid to the order of the Council of the Royal Astronomical Society, who have directed their Treasurer to invest a further sum of £55 15s. od. from their own funds, making together with the residue of the Horrocks' Fund a sufficient sum to purchase £100 Consols, which is to be set apart under the name of "The Horrocks' Library Fund," and the interest is to be devoted to the purchase of books to be deposited in the Library of their Society.

The only other fund already in existence in connection with the Library of the Royal Astronomical Society is the "Turner Fund," which consists of a sum of £450 Consols, and yields an income of £13 10s. od. annually. With this in the course of years many valuable books have been purchased; but the sum is not sufficient to meet the requirements of an astronomical reference library, and the new Horrocks' Fund, although small, will be a welcome addition to it.

The Chapter of Westminster having formally given its consent to the admission of a monument to Horrocks within the Abbey,

Dean Stanley set himself to select a suitable place for its erection, but was unable to find a niche more suitable than the one which it at present occupies beneath the sarcophagus or urn of Conduitt's monument.

The space was too small to admit of a lengthy inscription, and there were several important discoveries of Horrocks which it seemed necessary to mention. It was resolved, therefore, to eke out the space by making use of a block of marble with a curved surface, and by cutting the inscription in small letters. In deference to a wish expressed by a majority of the subscribers it was decided that the inscription should be in English. The Dean referred its composition to Professor Henry Smith and Mr Ranyard, who, with the advice and counsel of many of the subscribers, and after many alterations and emendations, finally submitted the following, which was approved of by the Dean:

In Memory of

JEREMIAH HORROCKS,

Curate of Hoole, in Lancashire,

Who died on the 3rd of January, 1641, in or near his 22nd year,

Having in so short a life

Detected the long inequality in the mean motion of Jupiter and Saturn;

Discovered the orbit of the moon to be an ellipse;

Determined the motion of the lunar apse;

Suggested the physical cause of its revolution;

And predicted from his own observations the Transit of Venus,

Which was seen by himself and his friend WILLIAM CRABTREE,

On Sunday, the 24th November (O.S.), 1639.

This Tablet, facing the monument of Newton,

Was raised after the lapse of more than two centuries, December 9, 1874.

The inscription having been cut a little lower upon the stone than was intended, it was suggested by the Dean that Horrocks' often quoted words, "Ad majora avocatus, quæ utique ob hæc parerga negligi non decuit," should be cut in smaller letters above the rest of the inscription. The sentence, being in Latin, and in distinct type from the body of the inscription, is not likely to be confounded with it. It has the merit of being somewhat enigmatical, and its explanation, or most probable explanation, presents at a glance the circumstances of Horrocks' life. It is also in his own Latin, and whatever be its meaning, it bears the impress of his character.

The inscription is cut in a block of very white marble, which

stands in the space beneath the lion's feet which support the sarcophagus of Conduitt's monument. It is longer at the bottom than above, and is ornamented at either end with acanthus leaf foliage, which passes under the lion's feet of the older monument. The white marble at present stands out in rather conspicuous relief against the time-stained stone of Conduitt's monument, which is opposite to that of Newton, whose niece, or rather, half-niece, Conduitt married. No doubt it was to some extent owing to this relationship with the great Sir Isaac, rather than to his own merits or to his official position at the Mint, that Conduitt obtained his place within our national Campo Santo, and the place of the Horrocks' tablet must rather be considered as opposite to the monument of Newton than as appendant to the monument of Conduitt.

Mrs. Conduitt was a daughter of Mr. Robert Barton, of Brigstock, in Northamptonshire, and Hannah Smith, Newton's half sister. On the death of her parents she was adopted by Newton, and for many years lived in his house. The sneer of Voltaire in ascribing Newton's promotion at the Mint to the beauty of this niece scarcely deserves our notice, except for the purpose of repelling the insinuation. Voltaire says in his *Dict. Phil.* tom IV., p. 61:—"J'avais cru, dans ma jeunesse que Newton avait fait sa fortune par son extrême mérite. Je m'étais imaginé que la cour, et la ville de Londres l'avait nommé par acclamation grand maître des monnaies du royaume. Point du tout. Isaac Newton avait une nièce assez aimable, nommé Madame Conduitt, elle plut beaucoup au grand Trésorier Halifax. Le calcul infinitésimal et le gravitation ne lui auraient servi de rien sans une jolie nièce."

Miss Barton was only sixteen in 1695, when Newton received his appointment at the Mint, and Lord Halifax could not then have seen her. That she afterwards grew to be a very fascinating woman and that she obtained great influence over the Lord Treasurer there can be no doubt. By a codicil to his will made in 1706 he bequeathed to her all the jewels he should have at the time of his death, and £3,000 "as a small token of the great love and affection he had long had for her." It must be remembered that the words "love and affection" were used more freely and did not convey quite the same meaning 150 years ago which they would now. Swift, for example, in writing to Stella says: "that he loves Mrs. Barton better than anyone here."

Swift, it is needless to say, was a great scandal-monger, especially when writing intimately to Stella; and if there had been the least suspicion of any impropriety of conduct between Miss Barton and Lord Halifax, Stella would undoubtedly have been told of it. But there is not the smallest insinuation of

anything of the kind. Swift frequently describes himself as having been at Miss Barton's "lodgings," by which term he no doubt referred to Sir Isaac's house in Martin Street, Leicester Square, where we may picture to ourselves the pleasing niece of Newton doing the honours of her uncle's table. There must have been something very bewitching about this companion of the great philosopher; she seems to have possessed good sense as well as beauty. One contemporary writes of her that she impressed all by her "excellent conversation." M. Montmart, a distinguished mathematician, says that he had heard of her wit and beauty before he visited England. In writing to Brook Taylor after he had seen her he expresses himself in terms compared with which those of Halifax read as if written with studied coldness. Montmart's letter is really a remarkable production, and shows that Miss Barton can have been no ordinary woman. The letter is given by Sir David Brewster in Appendix XIX. to his life of Newton. While on the one hand it must be borne in mind that Montmart was a Frenchman, on the other it will be remembered that he was a philosopher and an elderly married man, and that the mathematician to whom he was writing was rather seriously inclined. Brook Taylor came of a Puritan family, and about this time (1716) must have been engaged in writing his essays on Jewish sacrifices, and on the lawfulness of eating blood. He had been in Paris at the beginning of the year, and it would seem that Montmart had sent some wine by him to Newton. Miss Barton had also made use of Brook Taylor to convey her compliments to Montmart; the latter writes: "Ce seroit dommage que ce bon vin fut bu par des commis de vos douanes: étant destiné pour des bouches philosophiques, et la belle bouche de Mademoiselle Barton. Je suis infiniment sensible à l'honneur qu'elle (Mdlle. Barton) me fait de se souvenir de moy. J'ai conservé l'idée du monde la plus magnifique de son esprit, et de sa beauté. Je l'aimois avant d'avoir l'honneur de la voir, comme nièce de Mr. Newton, prevenu aussi de ce que j'avois entendu dire de ses charmes même en France. Je l'ai adorée depuis sur le temoignage de mes yeux, qui m'ont fait voir en elle, outre beaucoup de beauté, l'air le plus spirituel et le plus fin. Je crois qu'il n'y a plus de danger que vous luy fassiez ma déclaration. Si j'avois le bonheur d'estre auprès d'elle; je serais aussitôt et aussi embarassé que je le fus la première fois. Le respect et la crainte de luy deplaire m'obligeroit de me taire et à luy cacher mes sentimens: Mais à 100 lieues loin et separé par la mer je crois qu'un amant peut parler sans être téméraire, et une dame d'esprit souffrir des déclarations sans qu'elle puisse se reprocher d'avoir trop d'indulgence."

Thus loved and admired by philosophers, wits, and politicians, Miss Barton remained in Newton's house till the 24th August, 1717, when she married John Conduitt, Esq., M.P. for Cranbury, in Hampshire; a man much esteemed by Sir Isaac. The result of this marriage was an only daughter, Catherine Conduitt, who married in 1740 the Honourable John Wallop, afterwards Viscount Lymington, and died ten years after her marriage, leaving one daughter and four sons, from the eldest of whom the Portsmouth family are descended.

A correspondent writing to the *Times* from Oxford, soon after the erection of the Tablet, asked whether the lineal representatives of Mr. and Mrs. Conduitt had been consulted before the place for the Horrocks' Tablet was fixed upon? We do not know who the Dean and Chapter of Westminster may have felt it necessary to consult before making their decision; but of this we feel certain, that, could Miss Barton have been taken into council, she would have been the first to offer the hospitality of a niche upon her husband's monument to Horrocks, whose name has been too long forgotten by his countrymen.

List of Subscriptions to the Horrocks' Memorial Fund.

	£	s.	d.
Adams, Prof. J. Couch, *Late President of the Royal Astronomical Society*	1	1	0
Airy, Sir G. Biddell, *Astronomer-Royal*	1	1	0
Arundell, The Hon Mrs. Henry...	1	1	0
B., J....	1	1	0
Barrow, F., Esq., ...	1	1	0
Brickel, The Rev. Robert	1	1	0
Burns, George, Esq.	1	1	0
Burns, John, Esq.	1	1	0
Candy, Prof. F. J.	1	1	0
Canterbury, The Most Rev. the Archbishop of	1	1	0
Carlisle, The Rt. Rev. the Bishop of	1	1	0
Christie, W. H. M., Esq.	1	1	0
Close, The Rev. M. H.	1	1	0
Cottham, Samuel, Esq....	1	1	0
Coutts, The Baroness Burdett	1	1	0
Crosfield, William, Esq.	1	1	0
Dean, Mrs.	0	5	0
De la Rue, Warren, Esq.	1	1	0
Derby, The Rt. Hon. the Earl of	1	1	0
Devonshire, The Duke of	1	1	0
Dunkin, Edwin, Esq.	1	1	0
Esdaile, J. Kennedy, Esq.	1	1	0
Exeter, The Rt. Rev. the Bishop of	1	1	0
ffanington, Miss	1	1	0
Farrer, W. J., Esq., *High Bailiff of Westminster*, per Baroness Burdett Coutts	1	1	0
Fryer, Charles, Esq.	1	1	0
Galton, Francis, Esq.	1	1	0
Gladstone, Prof. J. H.	1	1	0

	Continued £	s.	d.
Grant, Prof. Robert	1	1	0
Gwilt, Mrs. Jackson	1	1	0
Harrison, William, Esq.	1	1	0
Harrowby, The Rt. Hon. the Earl of	1	1	0
Hermon, Edward, Esq., M.P.	1	1	0
Herschel, Capt. John	1	1	0
Hooke, Mrs.	1	1	0
Hoole, The Parish of	5	5	0
Houghton, Lord	1	1	0
Huggins, William, Esq., *President of the Royal Astronomical Society*	1	1	0
Johnson, J., Esq.	1	1	0
Jevons, Prof. W. S.	1	1	0
Knott, George, Esq.	1	1	0
Lassell, William, Esq.	1	1	0
Lindsay, Lord, M.P.	1	1	0
Lockyer, J. Norman, Esq.	1	1	0
Manchester, The Rt. Rev. the Bishop of	1	1	0
Matheson, John, Esq.	1	1	0
Mott, Albert, Esq.	1	1	0
Nursing Rao, A. V., Esq.	20	0	0
Orme, Mrs. Charles	1	1	0
Patmore, Mrs. G. M.	1	1	0
Picton, J. A., Esq.	1	1	0
Pollard, William, Esq.	1	1	0
Proctor, R. A., Esq.	1	1	0
R., C. E.	0	5	0
Ranyard, A. C., Esq.	1	1	0
Ranyard, S., Esq.	1	1	0
Rogerson, George B., Esq.	1	1	0
Rosse, The Earl of	1	1	0
Rowley, Mrs.	1	1	0
Shuttleworth, Sir James Kay	1	1	0
Sidebotham, J. K., Esq.	1	1	0
Smith, Prof. H. J. S.	1	1	0
Styles, Frederick, Esq.	1	1	0
Thomson, Sir William	1	1	0
Wilson, Thomas, Esq.	1	1	0
	£89	16	0

Examined 21st December, 1875,

J. C. ADAMS, R. GRANT,
R. BRICKEL, GEORGIANA PATMORE,
A. COWPER RANYARD.

	£	s.	d.
Fee to the Dean and Chapter of Westminster	£25	0	0
Fee to the Surveyor of the Dean and Chapter of Westminster	1	1	0
Paid to Messrs. Poole & Sons, Stone Masons	25	0	0
	£51	1	0

	£	s.	d.
Balance paid to the order of the Council of the Royal Astronomical Socie'y	£38	15	0

ROYAL ASTRONOMICAL SOCIETY.

Session 1876—77.

First Meeting of the New Session, March 10th, 1876.

William Huggins, Esq., D.C.L., LL.D., F.R.S., *President*, in the Chair.

Secretaries—Mr. Dunkin and Mr. Ranyard.

The minutes of the January Meeting were read and confirmed.

The following candidates for the fellowship of the Society were balloted for and duly elected:

William James Allsup, Esq, 5, Eastcombe Villas, Blackheath.

John William Durrad, Esq., 12, Lincoln Street, Leicester.

The Rev. Joseph Ferguson, 108, Lupin Street, Birmingham.

Sixty-six presents of the ordinary class were announced—in addition to these a very valuable gift has been made to the Society of some two hundred volumes, which have been selected from the library of the late Mr. Sheepshanks, who was for many years one of the secretaries, and was otherwise intimately connected with this Society. Mr. Ranyard read a list of some of the most valuable of the books. Amongst them were the *Opera Posthuma* of Horrocks, Smyth's *Celestial Cycle,* The B. A. Catalogue, Hevelius's *Annus Climactericus,* and *Prodromus Astronomiæ,* and nearly a complete set of the *Astronomische Nachrichten,* up to Vol. XLI. Lord Lindsay has also presented to the Society the Sun Spot MSS., and observations of the late Mr. Carrington. They were recently sold by public auction, and twelve guineas was bid for them on the part of the Society, but they were knocked down to a bookseller, from whom Lord Lindsay has since purchased them for the purpose of presenting them to the Society. The MSS. consist of three folio volumes of drawings of sun spots, made on a scale of twelve inches to the sun's disc. In all cases the whole of the sun's disc has been drawn and the position of the north point and the sun's axis has been laid down. There are also three large quarto volumes of observations of the positions of spots, which were made by observing the intervals of time between the transits of the spots and transits of the sun's limb across wires in a fixed telescope. There are seven large quarto volumes containing the reductions of these observations, and also a folio volume filled with drawings of groups of spots as seen on successive days, and placed one below the other on the page, so as to show at a glance the history of the group and its drift in heliocentric latitude and longitude.

The Society's library was already rich in MSS. of sun spot observations, but these will form a very important addition to the collection, as they contain the data from which the most accurate determinations of the position of the sun's axis, and the drift of the photosphere in the various heliocentric latitudes have been determined.

The President: I am sure it will be pleasant to everybody to hear that at the Council to-day a special vote of thanks was passed to the representative of the late Miss Sheepshanks, which will be conveyed to him in the name of the Society, for his very valuable addition to our library. A vote of thanks was also passed to Lord Lindsay for the very valuable contribution he has made to the manuscripts which we already have. We already possess manuscripts of considerable value, but I would take this opportunity of suggesting that it would be well if Fellows of the Society who possess manuscripts connected with valuable astronomical work would all deposit them in the archives of our Society. I have to ask you to give your thanks to the other donors of the presents of books. (Hear, hear.)

The Rev. E. Ledger, the new Gresham Professor of Astronomy, was then formally admitted a Fellow of the Society.

The President: I may mention that I have received a communication from South Kensington with reference to the approaching Loan Collection of Scientific Instruments, asking me to bring the subject before this meeting, and to invite the Fellows of the Society to lend any instruments of special interest which they may have in their possession. I place upon the table some papers which have been sent from South Kensington. These papers state more particularly the special points of interest which they seek in the instruments to be shown. I have also some forms to be filled up by any who may be willing to lend instruments to the exhibition.

Mr. Dunkin: I am requested by the Treasurer to read the following names of gentlemen who are in arrear with their subscriptions, and whose names it is proposed to suspend previous to expulsion. [A list of eight defaulters was then read.]

The President: Is it the wish of the Society that these names be suspended in accordance with the bye-laws?

Mr. Dunkin: Of course, each of these gentlemen will be written to after their names are suspended. They have already been written to once, but they will be written to again. Last year we suspended the names of twelve gentlemen, and before the time for expulsion came nine of them had paid their subscriptions.

Mr. Dunkin then read a paper by Mr. Pogson *On occultations*

of the Pleiades observed at Madras. The times were given of the disappearances of a great many of the small stars. An error of ten seconds as to one of the times was referred to. Mr. Dunkin said that the most interesting part of the communication seemed to be that half the observations were made by his daughter, Miss Pogson, who appears to be the chief assistant at the Madras Observatory.

Mr. Pogson had noted that he had seen six stars with the naked eye, but Mr. Dunkin said that persons in England had seen much more than six.

Sir G. B. Airy: Either twelve or fourteen, I do not exactly remember. Before you proceed, I would ask whether the error referred to of ten seconds has been established by the discordance of two observers, or by any other method?

Mr. Dunkin: Simply by the discordance between two observers.

Mr. Jackson said: Mr. Carrington told me the last time he was in this room that he had seen fourteen stars in the Pleiades with his naked eye.

Mr. Dunkin: The error of ten seconds was most likely an error in the counting of the clock.

Mr. Dunkin read a paper by Professor Zenger *On a Stereo-micrometer*, an apparatus to be fitted to a refracting or reflecting telescope, and to be used for measuring small angles in the field of view, as, for example, for measuring solar protuberances or solar spots. It was also intended to be used as a day eye-piece to give the position of any terrestrial object by directing the telescope to two different points. It appeared to be an instrument devised for measuring by noting the position of the object with respect to a series of squares.

Mr. Bidder: How are the squares constructed?

Mr. Dunkin read the explanation in the paper.

The President: The principle, then, consists in seeing the image of the object with one eye and the micrometer with the other.

Mr. Bidder: It is applying a principle that has been long used in microscopy of looking at the scale with one eye and through the microscope with the other, and uniting the two images, or superposing them, and then measuring the image by reference to the graduations of the scale.

Mr. Dunkin said he had a paper by the Astronomer-Royal *On the Observations of the November Meteors,* made at Greenwich. The Astronomer-Royal considered it important that these observations should be published at once in the *Monthly Notices* without waiting for the issue of the Greenwich volume.

Mr. Dunkin then read another paper by the Astronomer-Royal *On Micrometer Measures of Saturn's Satellites,* made in 1875; an important series of observations had been made at Greenwich with the great equatorial. The Astronomer-Royal was also anxious that these observations should appear in the *Monthly Notices.*

Sir G. B. Airy: With regard to these papers, I am anxious that such observations as those of the November meteors should appear early, because I think the important connection established by Schiaparelli between the paths of some meteors and comets makes it desirable to work on that subject as closely as possible. With regard to the other—the measure of the positions and distances of the satellites of Saturn—I will only make this remark—there is nothing in the observations that deserves to be commended, but what led to the observations deserves to be noticed, viz.: the ephemeris of Mr. Marth. I cannot too much impress on the Society the importance, when anything is expected to occur, of furnishing the best prediction that can be made, and it will then be sure to be observed, and observed pretty well.

Mr. Dunkin: I suppose that without the ephemeris of Mr. Marth we should not have made a single observation of this kind at the observatory.

Dr. Royston-Pigott read a paper entitled *A Note on a Starlit Transit Eye-piece.* He explained that the eye-piece was star-illuminated, and consisted of transparent lines drawn on a thin film of silver of a fine blue tint, which was deposited by Martin's process. This film permitted the star to be seen partly through the film and more brightly when flashing across the vertical parallel transparent lines. The breadth of the lines could be so regulated that more or less of the spurious disc of the star could be shown in transit. The lines could be ruled with great exactness to within a $\frac{1}{10000}$ of an inch, which corresponded to the $\frac{1}{40}$th part of a second in time, with an instrument such as he had been using. In the centre, below the film, was an indicator visible by starlight; and the film was removed at the sides so as to permit of the approach of the star to the transparent lines being seen. The film can be deposited to any degree of opacity, and can be renewed at a small cost. The silver film appears to answer very much better than any other film he had hitherto tried. Messrs. Horne & Thornthwaite have beautifully carried out his design, and have placed an instrument at the disposal of the observatories of Greenwich, Oxford, and Cambridge, and also at the disposal of Lord Lindsay and Dr. Huggins.

The President: There is one point I would ask,—whether the film is sufficiently thin for the star to be seen so that the observer is prepared for its transit?

Dr. Pigott: I think you will see that that is in a great measure provided for. The star is perfectly bright till it comes on the film; then it becomes rather dull. You disregard this because there is no flash, but the moment it comes to each line there is an instantaneous flash which occurs with the utmost regularity. There is no great advantage in having many lines, except so far as regards personal equation. But there is one point worthy of notice. If these lines had been ploughed upon glass with a convex groove you would not have a perfect image of the star; but here the surface being flat you do not see the diffraction lines or spurious rings. It may be interesting to know that I have seen with it stars of the sixth magnitude with my equatorial and with the ordinary transit instrument. The thickness of the film and the distances of the lines must of course be proportioned to the power of the instrument.

Mr. Dunkin: What stars of the smaller magnitudes can you observe?

Dr. Pigott: It depends on the size of the telescope and the thinness of the film. Mine is a $5\frac{1}{4}$ inch achromatic.

Mr. Dunkin: In ordinary transit observations we do not care to stop out the light, we like to see the star come in and pass across the field. I do not see the advantage of this instrument in observing large stars. If you could manage to observe very small stars then I could see an advantage. I am not speaking against its usefulness, but observers do not want to take observations of stars of the third and fourth magnitude with a dark field.

Dr. Pigott: Perhaps amateurs might find some benefit from it.

Captain Noble: There would be, I think, a serious practical objéction with ordinary transit observers, who do not possess chronographs, to this contrivance, arising from this fact that, while we with the ordinary wires split intervals of a second by the eye, Dr. Pigott does it solely by the ear, and I think it will be found that the ear is much less sensitive than the eye. [Captain Noble illustrated his meaning on the black board.] The observer notes with his eye the distance that the star is from the wire on hearing the last tick of the clock before the star comes up to the wire, and again notes the distance of the star from the other side of the wire on hearing the next tick after the transit—and by mentally comparing these two distances he learns to estimate with great exactness the fraction of the second at which the transit takes place. This may be called the eye method of judging time—but with Dr. Pigott's instrument the observer would only have his ear to rely upon, and he thought that it would be found that the ear was much less sensitive than the eye for such a purpose, and for ordinary observers who had learnt

to depend upon their eyes, the old plan would be distinctly preferable. Then, again, he thought that it would be found that there was an element of surprise in waiting for a flash, which would put observers out, and greatly increase their personal equation.

Dr. Pigott said: I am particularly glad that you have mentioned this, because I think I can remove these objections. Particular care is taken to keep these films of such a transparency that the star is seen during its whole passage. You see the star before it comes to the line, a little dim it is true, but perfectly visible, and then it flashes brighter as soon as it comes to the line.

Mr. Ranyard: Is the line also visible before the star comes up to it?

Dr. Pigott: Very often it is.

Mr. Bidder: But you are not dealing with stars all of the same degree of brightness, and a film suitable for a star of the 1st or 2nd magnitude might render a star of the 6th or 7th magnitude invisible except at the moment of the flash.

Dr. Pigott: I can only recommend you to try it. I do not find that difficulty myself.

Sir G. B. Airy: I will only make one remark, which is not to the main question of this paper, but to one sentence of it. Mention was made of lines being ploughed on the surface of the glass, thereby causing rough edges. That is not the way the best lines are made. They are made by etching; instead of the lines being ploughed, they are drawn on a fine film of wax; some of the etched lines I have at the observatory are most beautiful. I will ask any one to look at the lines etched in my dip instrument at the Greenwich observatory. I have seen no lines traced upon metal at all comparable to them for sharpness.

Lord Lindsay: I have to thank Dr. Pigott for placing one of these instruments at my disposal; but it seems to me that if the star appears with a sudden flash, I should be put out considerably until I had gained a great deal of experience. One is so accustomed to see the star come up slowly and go behind the web without any appreciable change or sudden alteration, that I fear this flash would give me a sort of mental shock.

Dr. Pigott: I have not experienced any shock myself in my observations, because I have seen the stars through the film gradually walk up to the film and then become dim, and then go on from line to line.

Mr. De la Rue: I was very much struck on looking at this little instrument, at the very splendid definition of the edges of the lines. It occurred to me that, for some purposes, possibly it would be advantageous to have dark lines and a larger

interval of clear space. I would suggest that a film of gold can be produced of sufficient opacity, much thinner than that of silver, it produces a green light when seen upon the ordinary light of the sky.

The President: We have to thank Dr. Pigott for calling our attention to this very ingenious form of transit eye-piece. I cannot help thinking it may be of great service in particular transit observations. No doubt the objections which have been made are valid, but at the same time for certain classes of observations in which stars of particular magnitudes only have to be observed it may do great service, and I am sure we have to thank Dr. Pigott for calling our attention to it. (Hear, hear.)

Captain Abney read a paper *On Photographing the least refracted part of the solar spectrum.* He said within the last two years there had been many attempts made to photograph the less refrangible rays of the spectrum; it was stated to have been accomplished by the Daguerreotype process, but there was reason to believe that the action spoken of was effected by fogging on the slightly exposed sensitive iodide.

Dr. Vogel in 1874, and more recently Captain Waterhouse, of the Bengal Staff Corps, had both resorted to aniline dyes, using them as colouring matter to the collodion. The red end of the spectrum was found most sensitive when a red dye napthaline was used. This colouring matter was regarded as an essential. He (Captain Abney) had carefully repeated the experiments of Dr. Vogel and Captain Waterhouse, but had only obtained partial success. Looking to the chemistry of the question, he had undertaken experiments with gum-resin, and other hydro-carbons added to ordinary collodion, and with every gum-resin he obtained considerable success; but at length he procured the ordinary gum-resin of commerce, which formed a white compound with silver, and seemed to be capable of taking an image far below A. He had obtained impressions which were constant on each plate. During the past winter, however, the sunlight had been very bad, and it was only at long intervals that we had been able to catch the sun for this purpose. To sum up the experiments:—if the gum-resin is added to collodion the ultra-red rays may be photographed, and the absorption lines very readily shown. It was only a want of focus that had prevented him bringing specimens to the meeting, as he would rather bring perfect specimens. When the sun was better he should be glad to lay the results of future experiments before the Society.

The President: The subject brought to our notice by Captain Abney is one of extreme importance, because at the present day we know the great value of recording the lines of the solar

spectrum and the bright lines of the elements by means of photography rather than by measurement. At present, attempts of this kind have been limited to the more refrangible part of the solar spectrum. I am sure the whole scientific world will be greatly indebted to Captain Abney if he provides a method by which the lines of the other part of the spectrum can be photographed. I would ask, whether the process is sufficiently sensitive for the bright lines of the elements from E to A, supposing they were produced in the electric arc?

Captain Abney: It is perfectly sensitive. An exposure of ten minutes will allow you to get down to A.

Mr. De la Rue: Does that exclude the other part of the spectrum?

Capt. Abney: You can exclude it if you like.

Mr. De la Rue: This is an important step in advance over the experiments of Dr. Vogel. He operated in this way. He introduced certain coloured pigments chiefly derived from hydrocarbons, and if he wanted to photograph the red for example, he put in a red dye, which excluded the other parts of the spectrum. Capt. Abney's generalization is a very much more important one, because it has nothing to do with coloured pigments, but only with a compound of silver. If hydro-carbons are likely to prove of service in this extension of the art of photography, it is a very important thing to know that hydro-carbons abound to a very great extent in nature, and offer a field which is practically unlimited. I possess three photographs which Becquerel made of the entire spectrum in its natural colour; and as that has been produced we look forward of course, some of these days, to obtain photographs in their natural colours. There is no absolute reason against it.

Lord Lindsay: You must find something to fix them with.

The President: What will be the relative rapidity of impression of the different parts of the spectrum.

Capt. Abney: If you take the indigo as 15, the green might be put down as 10, the yellow as 5, and A as 1.

The President: Therefore, if the indigo is photographed in one minute it would take 15 minutes to photograph the red A.

Capt. Abney: I cannot say that practically, because I do not always use glass, but an opaque plate, so that I do not get the irradiation to the extent you would expect, by which a more accurate idea of the over-exposure would be obtained.

Lord Lindsay: Would Capt. Abney be able to make a photograph of a red flame coloured with potassium?

Capt. Abney: A flame would be very difficult.

Lord Lindsay: But you photograph the bright lines?

Capt. Abney: Yes.

The President: And of course you can photograph the dark lines of the spectrum?

Capt. Abney: Yes.

The President: Do you know to what extent the wave lengths below those visible to the eye can be photographed—in what is called the heat spectrum—to what extent below the A lines? Have you any idea?

Capt. Abney: At present I have got about an equal distance below A to that between A and D.

The President: That is very good.

Mr. Neison: I should like to ask a question connected with the chemistry of the subject. Gum-resin is a very wide expression; could not Capt. Abney limit it by saying what gum-resin he uses?

Capt. Abney: I did not mean to enter into the question fully. I do not know whether I use the best gum or not, and, therefore, I did not care to give specific names.

Mr. Neison: I do not mean particular names, but the particular branch of resins, because there are four or five extremely distinct branches of gum-resins that are chemically entirely independent of each other, and none are strictly hydro-carbons in the scientific sense of the word, though Capt. Abney has coupled that description with the name gum-resins.

Mr. Bidder: I think we ought not to press Capt Abney.

Capt. Abney: I shall be very glad when I have made further experiments to lay the results before the Society. I have no wish to hide my method.

The President: I am sure we shall be happy to receive any further communication from Capt. Abney. I can hardly speak too strongly of the importance of this discovery in connection with the great advance which we look forward to in spectroscopy through the application of photography. I will ask you to return our thanks to Capt. Abney.

Capt. Abney: I do not wish to seem to take any credit from Dr. Vogel and Capt. Waterhouse; it is only an extension of their experiments.

The President: It is a very great extension. I think we ought to regard it quite as an original investigation by another method altogether.

Mr. Dunkin said that last year he received a paper from Professor Smyth of Edinburgh, in which he pointed out some remarkable changes in the proper motion of the small star B.A.C. 793, which indicated that there must be some great disturbing body in its neighbourhood. It appeared important that the question

should be decided, and he had, therefore, made a comparison of some observations of the star, made at the Greenwich Observatory during the past winter, with others made by Lalande and Piazzi near the beginning of this century, and at Greenwich at the mean epochs of 1837, 1845, and 1855. He had also received a paper on the same subject from Mr. Stone at the Cape of Good Hope. Having read portions of these papers, Mr. Dunkin said, in summing up, that the evidence he had collected was sufficient to warrant the conclusion that the proper motion of this star has not really changed during the present century, and if any change, however small, had occurred, it must have been detected in the above comparison.

Sir G. B. Airy: The result of all the means which have been taken to determine the motion of this star is that we have now fairly got rid of one of those presumed discoveries which, when strictly examined, is found to have no foundation. (Laughter.) I look upon it, Sir, as important for two reasons; one of them theoretical and the other practical. The theoretical reason is this: where the rate of a star's proper motion undergoes considerable change, it implies enormous force. We cannot tell, of course, from what source the force arises, but it implies a force of whose magnitude and scale we have no idea. It implies a force that might bring the world to an end. (Laughter.) Now I think we have got rid of that fear in a great measure, and that the world will stand out our time. That is the theoretical point. It may be expressed in better language, perhaps, but it is worth considering. The other point is the practical point, that when an observer at an observatory, with good instruments, has fixed the place of a star in one year, he need not be afraid to fix the place of the same star in another year, for something good will come of it. The present error appears to have arisen from relying too much upon the observations of a single year.

The President: I am sure you will return your thanks to our valued secretary for his very important investigation.

Captain Noble: I should like to mention that I have received a book from M. Normand, of Havre, called *Mémoire sur les occultations d'étoiles par les planètes.* It contains an extremely ingenious theoretical method of determining the solar parallax, but whether the method will ever become of practical use remains to be seen. We are all familiar with the method of determining parallax by the measurement of the distance of fixed stars from the limb of Mars at the time when he is in opposition. M. Normand proposes to do the same thing by observing the occultation of stars by the limb of Mars. The theory is good

enough, but when we come to the practice we shall, I think, find it difficult. He wrote to me last autumn (having heard in some way, of which I am ignorant, that I had observed many hundreds of occultations) to enquire what I believed to be the amount of precision with which the occultation of a star by the moon could be observed. I told him that at the dark limb of the moon the only obstacles to absolute precision lay in the observer and his chronograph, but at the bright limb there might be an error of three seconds arising from irradiation and obliquity. Upon that he seems to have jumped to the conclusion that he will be able to obtain equal precision in the case of Mars occulting small stars. But we must bear in mind that in 1877 there will be few stars that Mars will occult, and I want to invite the attention of observers with large telescopes to this method (it is no use for anybody else to try) and ask if they would, during the next opposition of Jupiter, observe if Jupiter passes near to any minute stars, and see if it is possible to observe their occultation with any degree of precision. We are told that Mars has an invisible atmosphere; if it be so, the approach of Mars to a small star might be signalised by its fading out, and we should see nothing at all of an instantaneous character about its occultation. I may be mistaken in this, but it is for the purpose of getting at the truth that I would ask the possessors of large telescopes to try and see when Mars and Jupiter become visible. [Sir G. B. Airy: Jupiter has too much light.] I should be afraid of that too, unless you could hide the limb by some contrivance; but I should like the possessors of instruments of sufficient size to make experiments as to whether the plan of M. Normand is feasible. I have no doubt it will be possible to form an ephemeris of the stars in the path of Mars. The theory is good, but it is open to the practical objection that the star may disappear altogether before it gets close to Mars.

Mr. Marth said, so far as he might judge from his own experience in 1864, when he was observing with Mr. Lassell at Malta, he could only look upon the suggestion as an impracticable one. The fainter stars in the neighbourhood of Mars became simply invisible, and how close to the limb brighter stars might really be seen and "observed" was not known, as occultations of brighter stars were very rare phenomena. It seemed very improbable that their observation, though very desirable and interesting for some physical investigations, could ever lead to any determination of the solar parallax of superior value.*

*[Note by Mr. Marth :—The chief instances I know of, when stars have been occulted by Mars, while the planet was being observed, are that of ψ^2 Aquarii, 5·4 m. on Oct. 1, 1672, that of *b* Sagittarii, 5 m. on April 17,

Lord Lindsay : Another objection I should imagine would be the impossibility of calculating the exact moment at which the occultation would take place. Consequently the eye would be so much fatigued with watching, that in all probability a wink would occur just at the moment of the star's disappearance. It is very wearisome waiting for an occultation at the limb of the moon unless you are very much accustomed to it.

Mr. Dunkin : Experienced observers have been known to make a mistake in this manner.

Mr. Marth asked leave to put a couple of questions. The first referred to Mimas, the inner satellite of Saturn. He had been glad to find it stated in the *Monthly Notices*, that a glimpse of the satellite had been obtained at the new Oxford observatory. Had the result been communicated to the Society? and had the satellite been seen anywhere else? Prof. Asaph Hall had had the great kindness to communicate to him some time ago last

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1796, and the much more promising experiences of Sir James South, with his 12-in. telescope, but they do not give much hope for the feasibility of determining parallax in that way. Considering the co-operation required, what, at the best, would be the degree of accuracy attainable? In comparison with such a very feeble chance of success, the prospect of the successful realisation of another fancy appears bright and promising. Do those readers, who have some fair acquaintance with the history of astronomy, not guess at once what old day-dream of astronomical science I am alluding to? It can do no harm to set them and others thinking about it. The opportunity for its realisation may not come for many years, it may not come for a century, but it *may* come next year, next month—and yet, how many observatories, though well furnished with the needed instrumental means, would be found prepared and really ready to grasp it? Yet, if it should be grasped to full advantage even by a single well placed astronomer, who clearly knows how to make the best of the opportunity, the resulting value of the solar parallax may not improbably turn out to be so decidedly superior to the values deduced from the transits of Venus and the oppositions of Mars, that the latter would have to be superseded. And the whole investigation, merely incidental as it would be to other work, need not cost, perhaps, as many extra shillings as the transit of Venus has cost hundreds of pounds.

When, in 1802, Pallas had been discovered, and it was yet uncertain what the orbit of Olbers' "movable star" might turn out to be, Zach, the Editor of the *Monatliche Correspondenz*, thought at once of the old day-dream, and explained in the course of his first article on the new discovery, "On a new, highly curious comet discovered by Dr. Olbers." (*Mon. Cor.*, Vol. v. p. 481, ff.) :—

"Astronomers have long wished for a comet of such a distinct and sharply defined form, as is shown by Olbers' star. If such a comet should pass at a distance from the earth, which is much less than that of the planet Mars or of Venus in perigee, accurate observations of its parallax would furnish a much more accurate means for investigating the parallax of the sun, and consequently the general measure of our planetary system, than is furnished by the so celebrated, and so rarely occurring transits of Venus across the sun's disc. Pingré says in his Introduction, p. 17 : 'Ceci suppose que la noyau de la comète sera assez net, assez éxactement déterminé, pour qu'on puisse observer ses passages

year's Washington observations of the satellites, which had now been published in the *Astronomische Nachrichten.* Though Hyperion had been observed on forty nights, there was only one observation of Mimas, which differed greatly from the ephemeris, but disagreed still more with some observations made in 1874 by Professor Newcomb. He had, however, since found out that the single Mimas observation of 1875 belonged really to Enceladus, while the observation of Enceladus, made on the same evening, belonged really to Rhea, and he was now very desirous to learn whether Mimas had not been observed or glimpsed anywhere, so that he might be able to ascertain the error of the ephemeris.

The other question which he wished to ask was suggested by a letter which he had received from a gentleman in Cambridge, Massachusetts, Mr. Trouvelat. Some years ago Mr. Marth had taken the trouble of computing the co-ordinates of all the leading

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avec une précision suffisante.' This can be done in fact, and with remarkable exactitude in the case of Olbers's comet. For such a determination, however, there is required another rare combination of favourable circumstances . . . . of which the most difficult one is, that such a comet must be observed at the same time by two observers very far asunder . . . . yet it would be possible that such circumstances might occur at some time." So far the extract from Zach's article. It needs scarcely be added that what Zach considered the most difficult condition, may, if circumstances are favourable (as in the case of the comet of 1770), be dispensed with altogether by employing the longest known practical method of determining parallax, the old method, which Kepler attempted to apply to Tycho Brahe's observations of Mars, which was first tried with some degree of success by Cassini and Flamsteed in 1672, which was fairly explained by Cassini in his tract on the observations of the great comet of 1680, which was afterwards applied by Maraldi to observations of Mars in 1704 and 1719, by Cassini II. in 1736, and treated by him in his *Eléments d'Astronomie* of 1740, as one of the two *then* well known methods for determining parallax—and which, it is to be hoped, will yield good results, when applied to Mars during next year's opposition. Observers who know what they are about will of course select their stars of comparison from the available star maps and catalogues with proper care, and will not omit from their list, for instance, one of the best stars available, Ll. 45504. 7·8 m., because it does not occur in Bessel's zones. Observers in Australia will, probably, not forget to look out for the close conjunction of Mars with ψ^3 Aquarii, on July 12, 1877, which, though the planet passes a minute more northerly than might be wished for, may be worth watching.

As regards the interesting sight of next year, the triple conjunction and long-lasting proximity of Mars and Saturn, it may, perhaps, not be out of place to mention that the last occurrence of that kind, but under far less favourable circumstances, took place in 1779, and that previously to that triple conjunctions occured in 1745, 1743 (a grand sight, as Jupiter was also in the neighbourhood), and 1706, but to get a triple conjunction, when Mars has been near its brightest, we must go back to the year 1640. The path which the planet will describe next year amongst the stars comes nearest to that which it described in 1593, when it was observed by Tycho Brahe.]

stars in a zone comprising the Milky Way, so that they might serve as a trustworthy groundwork for faithful representations of the Milky Way, which it was most desirable should be executed by skilful draftsmen, and indeed by all who were engaged in drawing nebulæ, for reasons which were sufficiently explained in a paper printed in the *Monthly Notices* for November, 1872. He was not aware whether any one in England had responded to the appeal then made, though he was in hopes that Mr. Wesley would act upon his suggestions and employ his skill in making drawings, when he should have the opportunity. Mr. Trouvelat had informed him in his letter that he had made sketches on the proposed plan, and that pastel drawings, founded on them, were to be exhibited at the Philadelphia Exhibition. What he wished to ask was whether anything in the matter had been done in England, so that he might be able to reply to Mr. Trouvelat's enquiries. He also wished to suggest that if any gentlemen present were going to the Philadelphia Exhibition they might not forget to look out for these astronomical drawings, and to examine them, and afterwards to make a report about them to the Society.

The meeting adjourned at ten o'clock.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

LUNAR NOMENCLATURE.

Sir,—Every practical student of Lunar detail must heartily endorse Mr. Neison's most pertinent and sensible remarks upon the ridiculous multiplication of names of objects upon the moon's surface. If, however, it be contended that such redundancy of nomenclature is calculated to facilitate the identification of small craters, &c., hitherto undescribed, then for goodness sake let us have some responsible body to select the names.

It is with mingled astonishment and disgust that I see in the last edition of Webb's *Celestial Objects for Common Telescopes* the appellations "Brayley," "Gwilt, G.," "Gwilt, J.," "Miss Sheepshanks," &c., attached to different objects.

If various Lunar formations are to be called after persons so little known as these, there can be no reason whatever why we should not have the "Sir John Bennett" ridge, the "Holloway" plain, or have some small twin-crater christened "Wilcox and Gibbs."

I make a present of this suggestion to the sponsor, or sponsors, of the additions to which I have referred. In the presence of his, or their, own nuncupation, it cannot be said to be

March 4, 1876. ALL MOONSHINE.

THE MINOR PLANET VESTA.

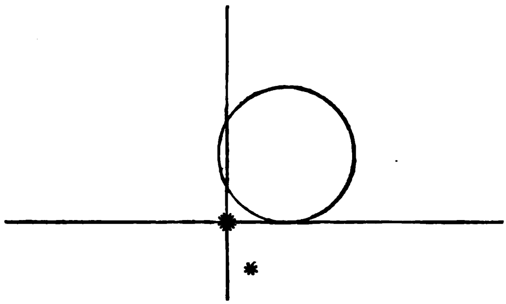
Sir,—It may interest some of your readers to know that one of the asteroids is now very plainly visible to the naked eye. This is Vesta; and I found it easily from the positions given in your periodical. It is not much fainter than Uranus, though at a much lower altitude in the evenings.

Yours truly,
T. W. BACKHOUSE.

West Hendon House, Sunderland:
March 20, 1876.

CONJUNCTION OF JUPITER AND β SCORPII.

The following diagram represents Jupiter and β Scorpii as seen here on Feb. 28, at 19h. 25m. Greenwich M.T. The cross lines show the micrometer wires, and it seems pretty certain that contact took place. The weather, unfortunately, prevented observation at the actual time of conjunction.



J. BIRMINGHAM.

Millbrook, Tuam.

OBSERVING WEATHER.

It has been suggested that a regular monthly notice of the observing weather of the previous month would be interesting and useful. We should be obliged to any regular and competent observers for reports, especially north and south of Scotland—north, south, and middle of England—south of France, north and south of Italy.

We append a note of the weather of February, by Mr. Gledhill, which will serve as a guide of the sort of notice required.

FEBRUARY, 1876.

No work possible on the 1st, 3rd, 6th, 7th, 8th, 9th, 12th, 13th, 14th, 16th, 17th, 20th, 21st, 22nd, 24th, 25th, 26th, 27th, 28th.

A few hours suitable for transit observations on the 2nd, 5th, 18th, 19th, 23rd.

Nights suitable for double star measurement, but bad in quality—4th, 10th, 11th.

Number of nights clear throughout—1, viz., the 10th.

J. GLEDHILL.

Mr. E. Crossley's Observatory:
Bermerside, Halifax.

ASTRONOMICAL OCCURRENCES FOR APRIL, 1876.

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. . m. Regulus
Sat	1	4 11 7 33 7 59	☽ Moon's First Quarter Occultation of 47 Geminorum (6) Reappearance of ditto	3rd Sh. E. 1st Oc. R. 3rd Tr. I. 3rd Tr. E.	11 27 11 32 13 35 15 2	— 9 19·5
Sun	2		Sidereal Time at Mean Noon, 0h. 44m. 41·23s.	2nd Sh. I. 2nd Tr. I. 2nd Sh. E.	13 12 15 5 15 46	9 15·6
Mon	3		Sun's Meridian Passage 3m. 11·69s. after Mean Noon			9 11·7
Tues	4	11 11 12 15	Occultation of 39 Leonis (6) Reappearance of ditto	2nd Oc. R.	11 45	9 7·7
Wed	5	3	Conjunction of Jupiter and β^1 Scorpii 0′ 3° S. Saturn's Ring: Major axis=35″·69 Minor axis=4″·81			9 3·8
Thur	6			1st Ec. D.	15 20 1	8 59·8
Fri	7	8 28 9 1 11 38 12 51	Occultation of B.A.C. 4225 (6½) Reappearance of ditto Occultation of *f* Virginis (6) Reappearance of ditto	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	12 56 13 48 15 8 15 59	8 55·9
Sat	8	7 38 7 14 8 7	○ Full Moon Occultation of 58 Virginis (6) Reappearance of ditto	1st Oc. R. 3rd Sh. I. 3rd Sh. E. 3rd Tr. I.	13 18 13 28 15 24 17 5	8 51·9
Sun	9			1st Tr. E. 1st Sh. I.	10 26 15 47	8 48·0
Mon	10	10 14	Occultation reappearance of B.A.C. 4923 (6)			8 44·1
Tues	11	11 24 11 56 15 45 17 3 18	Occultation of *b* Scorpii (5) Reappearance of ditto Occultation of π Scorpii (3) Reappearance of ditto Conjunction of Moon and Jupiter, 5° 53′ N.	2nd Oc. R.	14 5	8 40·2
Wed	12					8 36·2
Thur	13					8 32·3
Fri	14			1st Sh. I. 1st Tr. I. 1st Sh. E.	14 50 15 4 17 2	8 28·4

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage h. m.
						Regulus
Sat	15		Illuminated portion of disc of Venus=0·604 Illuminated portion of disc of Mars=0·962 Sidereal Time at Mean Noon 1h. 35m. 56·43s.	1st Ec. D. 1st Oc. R.	12 12 1 15 4	8 24·4
Sun	16	8 57	☾ Moon's Last Quarter	1st Tr. I. 1st Sh. E. 1st Tr. E.	10 0 11 30 12 11	8 20·5
Mon	17	15 44 16 52	Occultation of φ Capricorni (5½) Reappearance of ditto			8 16·6
Tues	18		Sun's Meridian Passage 0m. 48·60s. before Mean Noon	2nd Ec. D. 2nd Oc. R.	12 34 31 16 23	8 12·7
Wed	19	11	Conjunction of Moon and Saturn 0° 42′ N.	3rd Oc. D. 3rd Oc. R.	10 26 11 51	8 8·7
Thur	20			2nd Sh. E. 2nd Tr. E.	10 14 11 26	8 4·8
Fri	21			1st Sh. I.	16 43	8 0·8
Sat	22	1 2	Inferior conjunction of Mercury and Sun Conjunction of Neptune and Sun	1st Ec. D.	14 5 44	7 56·9
Sun	23	19 3	● New Moon	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	11 12 11 45 13 24 13 56	β Leonis 9 33·7
Mon	24	1	Conjunction of Moon and Mercury 3° 34′ S.	1st Oc. R.	11 16	9 29·8
Tues	25		Saturn's Ring: Major axis=36″·58 Minor axis=4″·43	2nd Oc. D.	15 8 51	9 25·8
Wed	26	7	Conjunction of Moon and Mars 4° 7′ S.	3rd Ec. D. 3rd Ec. R. 3rd Oc. D. 3rd Oc. R.	11 42 3 13 23 45 13 48 15 13	9 21·9
Thur	27	9 45 2	Near approach of 136 Tauri (5) Conjunction of Moon and Venus 1° 59′ S.	2nd Sh. I. 2nd Tr. I. 2nd Sh. E. 2nd Tr. E.	10 14 11 12 12 49 13 43	9 17·9
Fri	28					9 14·0
Sat	29			1st Ec. D.	15 59 31	9 10·1
Sun	30	10 26	☽ Moon's First Quarter	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	13 5 13 30 15 17 15 41	9 6·2
MAY Mon	1			1st Ec. D. 1st Oc. R.	10 28 2 13 0	9 2·2

THE PLANETS FOR APRIL.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	23 42 42	S. 4 28½	5″·5	22 58·2
	9th	0 34 6	N. 0 42½	5″·2	23 18·0
	17th	1 31 14	N. 8 24½	5″·0	23 43·5
	25th	2 26 35	N.14 37½	5″·1	0 11·2
Venus ...	1st	3 28 4	N.20 52	17″·1	2 46·9
	9th	4 5 10	N.23 15½	18″·1	2 52·4
	17th	4 42 25	N.25 3½	19″·5	2 58·1
	25th	5 19 18	N.26 13½	20″·9	3 3·4
Jupiter ...	1st	15 58 59	S. 19 27	39″·5	15 15·7
	9th	15 57 3	S. 19 20½	40″·3	14 42·3
	17th	15 54 25	S. 19 10	41″·2	14 8·5
	25th	15 51 10	S. 19 2½	41″·5	13 33·6
Saturn ...	28th	22 33 49	S. 10 38½	14″·8	13 20·4
Uranus ...	2nd	9 14 27	N.16 45	4″·0	8 28·9
	18th	9 15 27	N.16 40	4″·0	7 25·3

Mercury is badly situated for observation, but may be seen for about an hour after sunset at the end of the month.

Venus is visible for about four hours after sunset throughout the month.

Jupiter may be observed an hour and a half before midnight at the beginning of the month, the interval increasing.

Saturn rises one hour and three quarters before the sun at the end of month, and is badly situated for observation.

NEW MINOR PLANET (158).

(From *Astronomische Nachrichten* No. 2,079.)

Joseph Henry telegraphs from Washington :—

Feb. 25.		Planet (160).
Right Ascension.		Declination.
h. m.		° ′ ″
10 16	+	14 32 0
Magnitude 11.		Motion + 4.

V. KNORRE.

Errata in March number.—Page 60, line 21 from bottom, for *seconds* read *minutes*. Page 61. line 22 from top, for *implied* read *implies*. Page 62, line 4 from top, for *vigorous* read *rigorous*. Line 8 from top, for *debates* read *detects*. Line 9 from top, for *debated* read *detected*. Line 22 from top, for *vigorous* read *rigorous*.

LUNAR OBJECTS SUITABLE FOR OBSERVATION IN APRIL, 1876.

By W. R. Birt, F.R.A.S., F.M.S.

Fracastorius. As there is some reason to believe that the outline of this interesting formation has differed of late from former representations recorded within the last fifteen years, at least, there is now lying before us the engraving of a drawing made by Mr. Simms, of Thurso, Canada, on January 30, 1876, in which the outline of the northern border is almost the reverse of that depicted in several drawings varying in date from 1860 to 1865 inclusive. It may assist observers if we reproduce some notices of features in the border of Fracastorius as observed in those years.

I. *The Northern Border*. This border consisted in those years of *eleven low hills* of differing altitudes and sizes, connecting the eastern and western walls of Fracastorius. In the year 1861, September 23, we have the following record of an observation of these hills: "The interior of the western wall well illuminated. The northern boundary mentioned in the paper 'Monthly Notices, R.A.S.,' Vol. XX., p. 69, exceedingly well brought out. I count *eleven* very irregularly disposed between the N.E. and N.W. extremities of the series, these two points forming the northern extremities of the eastern and western walls of Fracastorius."

Mr. Simms in his drawing, "English Mechanic," March 3, 1876, p. 634, gives in the room of a portion of these hills a *wide bay*, with another adjoining it on the west, and extending beyond the remaining portion of the hills shown by Mr. Simms. Will observers please most carefully scrutinize the north border when near the morning terminator?

II. A small crater near the mountain δ of B. and M. It is situated on the extremity of the east wall, and when the terminator grazes the western edge of Fracastorius it is seen lying on the extremity of a ray from Tycho. I have never been able to detect the slightest indications of any hypsometrical relations in this ray, so near the terminator as it is when the sun is setting on Fracastorius, and when the least unevenness of ground is brought out at times with marvellous distinctness ; nor the slightest difference of level either on one side or the other; nor the slightest approach to anything like a shadow as connected with it, have I been able to detect. I have noticed this very remarkable characteristic: that the ray is more readily traced nearer the terminator than in the immediate neighbourhood of Tycho, *i. e.*, it is more easily seen under an oblique illumination ; most of the rays from Tycho require a more direct illumination.

III. A peak marked γ by B. and M.; it is near the peak δ and crater II.

IV. A crater on the extreme east of Fracastorius marked *d* by B. and M. ; it is somewhat depressed. This crater was finely seen 1863, January 24, 5.30, its ring finely illuminated and floor in darkness.

V. A peak on the northern part of the crater IV.

VI. The south-east angle of the border of Fracastorius. The external slopes of this angle, both south-west and north-east, *corrugated;* there are two lateral ridges on the south-west, two on the north-east, and three hillocks on the south-east ascent.

We hope that observers will make a point of looking for these six features both early and late in the month under the early illumination, and also a few days after the Full on the 8th, under the evening illumination. Drawings of the low northern wall will be very acceptable.

THE MINOR PLANETS CERES AND PALLAS.

The Minor Planets Ceres No. 1 and Pallas No. 2 of the series will come into opposition on the 25th and 10th of the month. The following are their positions over the meridian of Greenwich :—

CERES.

	Right Ascension. h.	m.	s.			Declination. °	′	″
April 1	14	49	48	...	S.	3	12	0
15	14	39	48	...	S.	2	33	27
25	14	31	6	...	S.	2	13	3

PALLAS.

	Right Ascension. h.	m.	s.			Declination. °	′	″
April 1	14	11	58	...	N.	16	24	10
13	14	5	33	...	N.	19	0	0

EPHEMERIS OF THE SATELLITES OF URANUS.

1876. 12h. Gr.	Ariel. pos. °	dist. ″	Umbriel. pos. °	dist. ″	Titania. pos. °	dist. ″	Oberon. pos. °	dist. ″
April 1	3	15	31	17	88	17	186	45
2	202	14	342	16	33	27	171	40
3	53	9	216	16	9	34	149	30
4	300	8	166	17	346	28	108	22
5	165	12	42	15	297	17	59	27
6	6	15	350	18	226	23	31	37
7	206	13	229	13	197	33	15	44
8	61	8	174	19	175	31	1	44
9	310	8	56	12	140	20	346	38
10	169	13	357	20	66	19	321	27
11	9	15	246	11	25	30	273	22
12	210	12	181	20	3	33	229	29
13	71	8	77	11	337	25	207	39
14	319	9	4	20	273	17	190	45
15	172	13	268	10	215	26	178	43
16	11	15	187	20	190	33	161	35
17	214	12	101	10	168	29	130	25
18	82	7	10	20	121	18	79	23
19	326	9	294	10	50	22	42	32
20	176	14	194	20	18	32	22	41
21	14	14	115	11	357	31	8	45
22	219	11	17	20	324	21	354	41
23	93	7	315	12	250	21	335	32
24	332	10	200	19	206	29	298	23
25	179	14	143	13	185	33	247	25

26	18	14	24	18	159	25	216	34
27	224	10	331	14	98	16	198	42
28	105	7	208	17	38	25	184	44
29	338	11	108	15	11	33	170	39
30	182	14	32	16	350	29	147	29

A. MARTH.

EPHEMERIS FOR PHYSICAL OBSERVATIONS OF JUPITER.

Greenwich Midnight. 1876.		Longitude of ♃'s central merid.		Angle of position of ♃'s axis.	Annual parallax.	Latitude of earth | sun above ♃'s equator.	
		°	°	°	°	°	°
April	1	114·9	870·7	11·74	− 8·07	−3·22	−3·04
	2	265·6	·7	11·76	−7·94		
	3	56·3	·8	11·78	7·81		
	4	217.1	·7	11·80	7·68		
	5	7·8	·7	11·82	7·54	−3·23	−3·03
	6	158·5	·7	11·84	7·41		
	7	299·2	·7	11·87	7·27		
	8	89·9	·8	11·89	7·13		
	9	240·7	870·7	11·92	−6·98		
	10	31·4	·7	11·95	6·83	−3·23	−3·03
	11	182·1	·7	11·98	6·68		
	12	332·8	·8	12·01	6·53		
	13	123·6	·8	12·04	6·37		
	14	274·4	·7	12·07	6·21		
	15	65·1	·7	12·10	6·05	−3·23	−3·03
	16	215·8	870·7	12·14	−5·89		
	17	6·5	·7	12·18	5·72		
	18	157·2	·8	12·21	5·55		
	19	308·0	·7	12·25	5·38		
	20	98·7	·7	12·29	5·20	−3·23	−3·02
	21	249·4	·8	12·33	5·03		
	22	40·2	·7	12·37	4·85		
	23	190·9	870·8	12·41	−4·67		
	24	341·7	·7	12·45	4·49		
	25	132·4	·8	12·49	4·31	−3·23	−3·02
	26	283·2	·7	12·53	4·13		
	27	73·9	·7	12·57	3·94		
	28	224·6	·8	12·61	3·75		
	29	15·4	·7	12·65	3·56		
	30	166·1	870·7	12·69	−3·37	−3·23	−3·02
May	1	316·8	·8	12·74	3·18		
	2	107·6		12·79	2·98		

A. M.

ASTRONOMY IN THE ELEVENTH CENTURY.

Astronomy was zealously cultivated by the Arabs in the East and in Spain, and seems also to have had some cultivators among the learned of Christian Europe. Latin translators existed of several Greek and Arabic astronomical works. In the history attributed to Ingulphus is the following curious description of a sort of scheme or representation of the planetary system called the Nadir, which is stated to have been destroyed when the abbey of Croyland was burnt in 1091:—"We then lost a most beautiful and precious table, fabricated of different kinds of metals, according to the variety of the stars and heavenly signs. Saturn was of copper, Jupiter of gold, Mars of iron, the Sun of latten, Mercury of amber, Venus of tin, the Moon of silver. The eyes were charmed, as well as the mind instructed, by beholding the colour circles, with the zodiac and all its signs formed with wonderful art, of metals and precious stones according to their several natures, forms, figures, and colours. It was the most admired and celebrated Nadir in all England." These last words would seem to imply that such tables were then not uncommon. This one, it is stated, had been presented to a former abbot of Croyland by a king of France.—*Sketches of the History of Literature and Learning in England,* &c., by G. L. Craik, M.A.

TO CORRESPONDENTS.

We are obliged to postpone reviews, subscriptions, and other matter from want of space.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to JOHN C. JACKSON, at Lower Clapton, London, E.

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The pages of the *Astronomical Register* are open to all suitable communications, Letters, Articles for insertion, &c., must be sent to the Rev. J. C. JACKSON, *Clarence Road, Clapton, E.*, **not later than the 15th of the Month.**

The Astronomical Register.

No. 161. MAY. 1876.

ROYAL ASTRONOMICAL SOCIETY.

Session 1876—77.

Second Meeting of the Session, April 12th, 1876.

William Huggins, Esq., D.C.L., LL.D., F.R.S., *President*, in the Chair.

Secretaries—Mr. Dunkin and Mr. Ranyard.

The minutes of the January Meeting were read and confirmed.

Sixty-seven presents were reported as having been received since the last meeting of the Society. Amongst these was a complete set of the transactions of the Stockholm Academy. The thanks of the meeting were formally voted to the donors.

The following candidates for the fellowship of the Society were balloted for and duly elected:

Sir David Salomons, Broomhill, Tunbridge Wells.
W. T. Smedley, Esq., 20, Colmore Row, Birmingham.
John Bagnold Smith, Esq., The Laurels, Chesterfield.
Thos. Watson, Esq., 15, York Place, Portman Square.

Mr. Dunkin: I have very few papers this evening. We must hope that some gentlemen will have something to say in discussion. The first paper is one by Mr. Stone *On the most probable results which can be derived from a number of distinct determinations with assigned weights.* This paper is purely a mathematical paper, and was written for the sake of being printed, and not read.

I have also a paper communicated by Mr. Main, which he has received from M. Flammarion. It contains a list of stars beyond the ordinary limits of distance inserted as double stars in Sir John Herschel's general catalogue of double stars. This paper also is not intended for reading. It consists simply of the names of the stars and the numbers in the catalogue. I may state with regard to this paper that M. Flammarion, who appears to be engaged on double star work, has been examining the catalogue of Sir John Herschel, published in the recent volume of the *Memoirs,* and he

has also written to me stating that a great number of the stars inserted in the catalogue are really not double but simply single stars and ought to have had no place in Sir John Herschel's catalogue. He wrote to me asking my opinion upon the matter, and at his request I have gone into the question a little, and I find that the stars that he objected to particularly are those which are contained in Smyth's Celestial Cycle, and they include nearly all the larger Greenwich stars. These large stars are placed as double stars in the catalogue, but of course, with few exceptions they are single, and Admiral Smyth in his celebrated work, "The Celestial Cycle," evidently considered them as stars having companions, many of them not close companions, but very distant comes. He has not, as a rule, included stars where the companion is at a greater distance than 5 minutes of arc; therefore as Sir John Herschel has compiled his catalogue including the whole of the "Celestial Cycle" stars, we cannot fairly call them errors in his catalogue. I see M. Flammarion has called them "beyond the ordinary limits of distance," but Mr. Main thinks it may be as well to print his paper in the *Notices*, and there cannot be any objection.

Mr. Knobel: There is one star in Smyth's cycle with a companion at a distance of 280 or 290 seconds. Mr. Powell, at Madras, first directed attention to it as he found a great discrepancy between his measurements and those of Admiral Smyth. I measured the same star and could not account for the great discrepancy I found between the distance of the star and its comes, but this, no doubt, has revealed a considerable proper motion. With regard to the companion of β Leonis, its proper motion would not have been so readily found out if Admiral Smyth had not included it as a double star in his catalogue, and therefore there is a great advantage in measurements having been made.

Mr. Dunkin: This star is one of those with a very distinct companion inserted in the celestial cycle. The observation of these standard stars has been considered of great importance at Greenwich; and formerly there was a select list of thirty-six stars, which were observed on every occasion possible. With our present knowledge of things we have extended our list of clock stars to more than 200; and there is no necessity now for observing these so continuously. We are perfectly content to rely on the places as found from fewer observations. These large stars were included by Admiral Smyth, and as I have remarked, he selected the nearest star to them which he has called the companion, and as such they are correctly entered in Sir John Herschel's catalogue.

Capt. Noble: In more than one case does not Admiral Smyth give the difference of R. A. in seconds of time?

Mr. Dunkin: Yes, it is true that he does do so. I have made a list, but there are seldom more than five minutes of arc in the greatest distance.

Mr. Knobel: In the "Prolegomena" to Admiral Smyth's cycle he gives a short list of the objects in the Bedford catalogue, and says it consists of so many double stars and so many with comites. I think about eighty-seven with comites.*

The President: I think Admiral Smyth does not include them under the description of double stars, but as stars with companions which are well worthy of observation, and as such, I think, they should be included in the catalogue, but distinguished in a class apart.

Mr. Penrose described "An instrument for determining spherical triangles by mechanical action." He produced a model which consisted of two planes formed of wood, hinged so as to revolve through an arc of 180 degrees. One of these planes is bounded by a semicircle and the other by an arc rather larger than the quadrant, but both were of the same radius. Below these two planes is a third plane at right angles to the axis about which the other two planes revolve. One of the two former has a radius bar so arranged that it will carry a sliding piece along its graduated edge, and to this sliding piece is attached, by a universal joint, a link or bar free at the other end, which is graduated with a scale of chords so that the arc of the third side of the triangle can be read off at once from the chord. By means of these three, it is obvious that any spherical triangle may be formed. Mr. Penrose proceeded to show how the more ordinary problems in spherical trigonometry may be experimentally solved with the instrument: thus, when three sides or two sides and the included angle are given, the operation is performed at once. When two sides are given and some other angle than the included angle, it needs a second operation to obtain the result. If two angles and one side are given, one must work with the supplementary triangle. Thus the instrument can be used for checking any sort of calculations, and if great accuracy is not wanted then it will serve instead of the calculations themselves. Even a rough instrument like the one shown, will give the time to about a minute or an arc to

*[Note by Mr. Knobel: The Bedford Catalogue consists of 850 objects comprising —

Nebulæ 98,	Binary Stars 20,
Clusters 72,	Triple Stars 46,
Stars and Comites 161,	Quadruple Stars 13,
Double Stars 419	Multiple Stars 21.]

about fifteen minutes. It would be useful in calculating heights and for any problems involving refraction, for example, for the ordinary seaman's problem of clearing a lunar distance. Then there are times when in partially cloudy weather the altitude of a star would be valuable, but the seamen would want to know for certain what star it was they were observing. By means of this instrument, the time and latitude being approximately known, they could roughly find the declination of the star they had observed, and so identify it. There are various other purposes to which the instrument could be very usefully applied. For example, the determination of the altitude of a meteor from a great many observations, which in most cases can only be roughly given.

The President: We are very much obliged to Mr. Penrose for his description of this exceedingly ingenious contrivance, which appears calculated to save a great deal of labour. I shall be be glad to hear any remarks.

Capt. Toynbee: When I was at sea the reduction of lunars was a favourite occupation of mine, and I wrote a few papers on the subject. My friend, Mr. Penrose, brought his instrument to my office, and I gave him out the observed distance and the altitude for a lunar, and set him down with his machine to calculate, I thought it the best test I could give. Either his instrument was exceedingly good, or he was an exceedingly fortunate man, for he hit the true distance to two seconds of arc.

The President: In more than one instance?

Capt. Toynbee: I did not offer another. The fact was we were working then. It was during office hours, and time was valuable, but I shall be very happy to supply him with a dozen.

Mr. Penrose: I should be disappointed if I did not get the answer to ten seconds.

Capt. Toynbee: It was the same result within two seconds of arc that I had calculated ten years ago. The instrument seems to me well calculated for checking observations or taking altitudes on shore, and I should think it could be used with advantage in the sort of work Lieut. Cameron has been engaged in in Africa.

Mr. Dunkin: How long did Mr. Penrose take?

Capt. Toynbee: I should say about five minutes at the outside.

Mr. Dunkin: I have had a good deal of experience in reducing lunars, and I know what a troublesome business it is. Having often gone through perhaps two or three observations made at one place, and found a considerable difference in the resulting longitude, much larger than might have been expected, I have been obliged to go through all the calculations again to find which

was right. If Mr. Penrose can calculate within ten seconds, I think his instrument will really be very useful for checking such work.

Capt. Toynbee: With the object of avoiding errors I always used to take two distances and calculate them together. Of course this instrument would check the one lunar. If I found a great difference I always went at the one which differed most from what I expected. An old friend of mine on the Revenue Board at Madras used to use an old slide rule for checking his calculation, and found it very useful.

Mr. Godsman: Though I have never used them myself, I have heard of nautical men using slate globes instead of celestial globes as a check. In cases where it is a desideratum to multiply a number of observations, as for instance, in the case of stars under different conditions of refraction, such an instrument as this would be very valuable. From what I see from here there is a great deal too much instrumentation about the instrument, but when matured I think it may be very useful, for the trouble of calculating a great number of lunars is very serious indeed. For smaller angles, I think, a slate globe can be used for the purpose, but irrespective of the heavier computations in dealing with the actual difference of the spherical triangle, I think for for that purpose the degree of accuracy which has been stated must be very valuable indeed.

Capt. Noble: I should like to ask Mr. Penrose whether this instrument is the one which brought out the result within two seconds of arc?

Mr. Penrose: The same instrument.

Capt. Noble: Because it is not divided within half degrees.

Mr. Penrose: In the operation of reducing a lunar it has the power of bringing 10 degrees of arc to bear upon a small quantity, perhaps of not more than 30 minutes, and for resolving this small matter of 30 minutes you get a proportion derived from a much larger quantity.

If you have a slide rule in addition to the instrument you will save a great deal of time, but it is but little trouble multiplying one short decimal by another short decimal, where you only want three figures in the answer.

Capt. Noble: I see, it is a matter of calculation of proportions.

The President: There is one point about the instrument that strikes me, that though it may not do more in some respects than the slate globe, it is far more portable, which in the case of a traveller would be a great advantage, especially in Africa, for instance. There is also the use of it as suggested by Mr. Penrose, namely, to find in a moment the apparent altitude of a star, and

on the other hand to find what the star is from the apparent altitude. It seems to me that the instrument would be a very great convenience. I will ask you to return our thanks to Mr. Penrose (applause.)

A paper by the Rev. T. W. Webb was read describing some observations of the two exterior satellites of Uranus, which had been made by Mr. Isaac Ward, of Belfast. Mr. Ward's instrument is a refractor by Wray, of only 4·3 inches aperture, but it would appear that he had succeeded on some dozen evenings during the months of January, February, and March in picking up both the outer satellites, Titania and Oberon. A table was given in the paper showing the position-angles, and distances, as estimated by Mr. Ward. They had been made without previous reference to any ephemeris, and in parallel columns were set out the position-angles and distances of the two satellites, as taken from Mr. Marth's ephemeris, published in the *Astronomical Register.* The coincidences were such that there seemed little room for doubt that Mr. Ward had been really observing the satellites and not small stars in the neighbourhood of the planet. Mr. Webb had also with his 9·4 reflector just glimpsed one of the satellites on the 24th of March. He says of it: I had occasional glimpses with a power of 212 of a very minute point of light, which, though of the most evanescent character, always, when visible, occupied the same position, and on referring to Mr. Marth's ephemeris the next morning I found that the point of light I had noticed was within blundering distance of Titania.

Lord Lindsay asked, how far the positions of Mr. Ward and Mr. Marth agreed?

Mr. Dunkin: Not always well, but fairly considering. I will read a few of the positions—some are good and some are very good considering the faintness of the objects.

The President: I think Mr. Lassell might give us some information. I do not know whether he has been able to see the satellites with so small an aperture.

Mr. Lassell: As far as I can judge, I should attribute these observations to the extraordinary excellence of Mr. Ward's eye. We find evidence in certain cases of extraordinary sharpness of sight. For instance, some persons have, without doubt, seen some of the satellites of Jupiter with their naked eye. There are some instances recorded of the satellites having been seen which cannot be disputed. I should think that these observations of Mr. Ward are of that character, and that if any one else were to take his telescope probably they would not be able to see them at all. I think it possible that Mr. Webb who has rather exceptionally good sight, might see them with a silver-glass speculum of 9

inches aperture, under favourable circumstances. I should like to know whether Mr. Ward tabulated every observation he made when he thought he saw a satellite, or whether he has only selected those which agreed with the ephemeris.

The President: It does not seem that these observations of Mr. Ward depended on exceptionally clear nights, because there is a long list of dates. He appears to have been able to see the satellites on any night of ordinary clearness.

Mr. Dunkin: I suppose he had more of these clear nights than we have had.

Mr. Marth said that these observations showed that it was the duty of those who possessed telescopes between 10 and 4 inches aperture to try whether they could see the satellites. The difference between 10 inches and 4 inches was so great that he was somewhat sceptical about the observations. There were so many 6, 7, and 8 inch telescopes in the hands of amateurs, that they certainly ought to have been able to see these satellites if Mr. Ward had done so with a 4 inch. Uranus was visible to the end of the month, and he thought the point might be settled in a couple of weeks.

Mr. Brett: Has any one else seen them with a 9 inch?

Mr. Marth: The positions of Oberon and Titania were observed by Lamont, of Munich, in 1836 or 1837, with a little over 11 inches of aperture, then Mädler glimpsed Titania with a 9½ inch refractor, but I do not remember anybody, except Mr. Dawes, who has seen them with a smaller telescope.

Mr. Brett: Then I am not much disgraced in never having seen them with a 9 inch.

Mr. Marth: This might have been tested with Mr. Lassell's 9 inch reflector, the definition of which is exquisite. I have never seen them with it, because whenever there was a chance of seeing them a bigger telescope was used.

Mr. Lassell: I have never seen the satellites with my 9 inch, but I have never seriously looked for them.

Mr. Marth: If they have never been seen with a 9 inch, I have great doubt about even a sharp-sighted observer being able to see them with a 4 inch. But then it is merely a doubt which gentlemen who have telescopes between 4 in. and 9 in. ought to solve in a fortnight.

Mr. Lassell: Neither Mr. Webb nor Mr. Ward could have made any observations so as to calculate anything like the actual place of the satellites with sufficient exactness to be made use of.

Mr. Talmage: During the last fortnight I have looked at Uranus with Mr. Barclay's 10 inch refractor. It was with the greatest difficulty I could see the second satellite, but occasionally I got a

fair glimpse, sufficient to take the measures of the brighter satellite. It is a very difficult thing. I should like to ask, if Mr. Ward did not know of the ephemeris, how did he know where to look for the satellite?

Mr. Lassell: He looked all round I suppose.

Mr. Marth reminded the meeting that two years ago Otto Struve had read a paper before the Society on the companion of Procyon; very lately, in a paper from Washington, he found they had tried with their 26-inch telescope to see the companion and they had not been able to do so, though they had seen three nearer companions. On the other hand, they had observed the small satellites of Uranus, which Otto Struve had not been able to see, though he had tried his best to do so. At St. Petersburgh, therefore, they can see the companion of Procyon, which cannot be seen at Washington, but at Washington they can see the small satellites of Uranus, which cannot be seen at St. Petersburgh. How was this riddle to be solved? It was to him a perfect riddle.

The President: We are indebted to Mr. Webb for laying this matter before us, because it may induce those who are the possessors of small telescopes to endeavour to bring a greater number of objects within their range. I can speak as to the satellites from my own experience. Some years ago I had a fine 8-inch object glass, made by Alvan Clark, which had belonged to Mr. Dawes. And for one or two years I was in constant correspondence with Mr. Dawes, who used to send me his most difficult things to look at. On one or two occasions I with great difficulty saw with my 8-inch some points of light near Uranus, which Mr. Dawes regarded as satellites, but it was only with difficulty that I could see anything that I could suppose to be satellites.

Mr. Brett, seeing Mr. Burton present, asked with how small an instrument he had seen the satellites of Uranus.

Mr. Burton: I have only seen them with a 12-inch silver on glass reflector; with which I had very great difficulty in seeing the two brighter ones. With the 6-foot instrument at Parsonstown on favourable nights, I had considerable difficulty in measuring the two fainter satellites.

Mr. De la Rue: I am very much disposed to think that Mr. Ward has made some mistake in identifying the satellites of Uranus with a 4-inch refractor. I never paid very great attention to the satellites of Uranus, well knowing that even with a 13-inch reflector a great deal of time might be lost. Instruments of large calibre are generally devoted to these observations, and from what I have seen of the brighter satellites occasionally, on very

rare occasions, with my 13-inch reflector of very good definition; I very much question the correctness of Mr. Ward's observations, not that I wish to impute any desire to publish observations which have not been made: I think only that they ought to be repeated by the same gentleman and with proper precautions for controlling them; let him follow the supposed satellites a little while and see if he can identify them as such, if they are not stars. I know how difficult it has been with the closer satellites of Saturn to be absolutely certain of the observations, and I really very strongly doubt that the brighter satellites of Uranus have been seen with a 4-inch refractor.

Mr. Dunkin then read a paper by the Rev. S. J. Johnson, *On the near approach of* 47 *Geminorum to the Moon, which occurred on the* 1*st of April last.*

Mr. Dunkin said this occultation was not observed at Greenwich; it was cloudy on that day. There are many occultations given in the *Nautical Almanack* which are not visible at Greenwich, but they are placed there because they might be visible at some place near Greenwich.

A paper *On the radiant points of shooting stars; observed at Bristol,* by Mr. Denning, was then read. The paper consisted chiefly of tabular matter, and afforded no opportunity for discussion.

The President announced that Mr. Green wished to make some remarks *On the visibility of the dark limb of Venus.*

Mr. Green said the subject links itself somewhat to that which had been already discussed. I wish to draw attention to the question of the possibility of seeing the non-illuminated side of Venus at certain seasons, chiefly from quadrature to inferior conjunction. My attention was first drawn to the matter some years ago, by Mr. Banks, of Ealing. We were making an observation of Venus when he said he could see the whole of the dark limb of the planet. It was then a little less than half full, approaching a crescent. I tried again and again without success. A year or so after, in Ireland, on one occasion, I consulted Mr. Burton, and he was quite certain that something could be seen, but we could not describe what, also Mr. Wentworth Erck, who was in the neighbourhood, corroborated his statement. Again, a little time after that, Mr. Banks was with me at St. John's Wood and we turned a 4-inch achromatic upon Venus. He said, "Why, there it is, as plain as possible." I looked earnestly, but could see nothing of the kind, at last I imagined I saw it occasionally, so I brought an eye-piece which had a small dark band in the field. I said to Mr. Banks, "Will you be kind enough to look for it when the crescent is behind the dark band?"

He said, "It is very strange, I cannot see it now, but I feel perfectly certain it is there." Now, Mr. Banks' eye is unquestionably a good one. He has on several occasions pointed out with the naked eye the satellites of Jupiter, and has tested their position afterwards by the telescope. Then again, with reference to the dark side of Venus, I showed the planet on the meridian to a friend, who had never seen her through a telescope before, and he said, "I see the whole round." I was quite staggered. I tried myself and could see nothing. I got the dark band and covered the illuminated portion, and he could not then see what he had seen before. The power was 120, a 9 inch silvered on glass mirror of the highest excellence. The last transit of Venus proves there is a luminous line visible round Venus, possibly arising from the atmosphere of the planet, as seen before it passes on to the sun's surface. This is clear both from the eye observations and the photographs. Is it possible that at other portions of the orbit of the planet, long before she comes into inferior conjunction, this same appearance is occasionally seen? I believe that in some instances it is an illusion, but it does not follow that it is always so. The present is a favourable time to look out for this specially exceptional appearance.

Capt. Noble: It is a very old story to tell you that I have observed every inferior conjunction of Venus for some years back, and upon every such occasion, save one, I have seen, as plainly as I see you, the dark limb of the planet projected on something. I use an ordinary Huyghenian eye-piece, and in place of a diaphragm a card perforated with a red-hot needle, so as to avoid any fringe, which is an annoyance. The hole is made just to take in the disc of Venus, and I have seen unmistakably the whole body of Venns, with the illuminated crescent like a hair of light around it, and the sky on the outside lighter than the disc, as though this were projected on the corona. That I have seen this on every occasion of inferior conjunction save one, I am prepared most certainly to affirm.

Mr. Green: Have you seen it at quadrature?

Capt. Noble: No. I never attempted it.

Mr. Green: I do not see what you gain by limiting the field.

Capt. Noble: The glare of the general field disturbs the eye. If you try the limited aperture you will find the advantage of it as I did.

Mr. Burton: The photographs that had been taken of the transit show that the appearance then seen was due to an atmosphere, and not to light upon the dark limb or the background of the corona.

Lord Lindsay: When I was in Mauritius, using a 6-inch

telescope, and double image micrometer, we found the planet had almost a ring of light, and we could imagine we saw the bright line continued, but the only way we could decide that it was not continued, except in imagination, was to put a small diaphragm in the double image micrometer and cut off the bright part altogether, and then we could see that the bright line did not go all round. We were not able to see any crepusculum or anything of that description, showing any part of the dark limb.

Mr. Neison: If you take the case of the moon when past the first quarter, you can see the dark portion by cutting off the bright part, but you will not be able to see the dark portion if you conceal the greater part of it as well as the bright side.

Mr. Marth mentioned that lately there had been a paper published in Vienna, in which the author had put together all the instances known in which the dark side of Venus had been observed. He had not yet seen the paper itself, which was probably in the Society's library, but only knew the account of it given by Winnecke in a publication of the Astron. Gesellschaft.*

The President: I am sure we are very much obliged to Mr. Green for calling attention to the subject, and also to Mr. Marth for directing our attention to the paper of Mr. Winnecke, which those who are at leisure will be able to study more minutely.

The meeting adjourned at Half-past Nine till Friday, the 12th of May.

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* [Note by Mr. Marth :—The paper itself is by Mr. A. Safarik, and printed in the *Notices of the Bohemian Academy of Sciences*, of July 18, 1873. Winnecke's account of it is found on page 213 ff. of vol. 9, of the *Vierteljahrs-schrift der Astron. Gesellschaft*.

It may, perhaps, be well to reprint here the oldest known statement of the secondary light of Venus having been observed, which is found in the first edition (of 1715) of Derham's *Astro. Theology*, Book V. Of the figure of the several globes of the Universe.

". . . . . . And this sphaericity, or rotundity, is manifest in our *Moon*, yea, and in *Venus* too; in whose greatest falcations the dark part of their globes may be perceived, exhibiting themselves under the appearance of a dull and rusty colour."

To the third edition (of 1719) a footnote is added.

"What I have here affirmed of the *Secondary Light of Venus*, I have been called to an account for, by an ingenious astronomer of my acquaintance. But I particularly remember, that as I was viewing *Venus* some years ago, with a good 34 foot glass, when she was in her *Perigee*, and much *horned*, that I could see the darkened part of her globe, as we do that of the *Moon* soon after her change. And imagining that in the last total eclipse of the Sun, the same might be discerned, I desired a very curious observer that was with me and looked through an excellent glass, to take notice of it, who affirmed that he saw it very plainly.

The total eclipse here alluded to was obviously that of May 2 (N.S.) 1715, when Venus was a morning star already beyond her greatest elongation.]

REVIEW.

Notes of a Voyage to Kerguelen Island to observe the Transit of Venus, December 8th, 1874. By the Rev. S. J. Perry, F.R.S. Reprinted from the *Month and Catholic Review.* Manresa Press: Roehampton. 1876. 48 pp.

This is a very interesting and well written pamphlet. In carrying out the important object of the expedition the writer and his assistants had to endure hardships and dangers; and they deserve all praise for the skill, perseverance and endurance which they manifested. The way in which difficulties were overcome, mishaps rectified, and a fair amount of success achieved, in spite of adverse elements, envious skies, and no little personal discomfort, reflects on the Rev. S. J. Perry and his coadjutors a high degree of credit. It is impossible to conceive, after reading this account, what more they could have done, or how they could have done better. We give a few extracts from the narrative.—"Among the many expeditions sent out by England or her colonies for the observation of the transit of Venus last year, few, perhaps, attracted more attention or excited more interest than that destined for the Land of Desolation. Its excellent geographical position gave it special claims, situated as it is at the spot best suited as a south station for the application of Halley's method of total duration, and as an east station for retarded ingress to pair with Honolulu in Delisle's method, and at the same time being nearly as good for the direct as for the indirect mode of attack. And then the desolate situation, almost three thousand miles away from any habitable spot; the dreary aspect of an island of rock and lake and bog, without man or beast or tree to break the monotony of its loneliness; and, most of all, the fearful approach through mist and storm, with waves the greatest in the world, and winds blowing a gale five days out of every seven. All tended to create a sympathy for those who had the honour of being entrusted with this important post" (pp. 2, 3). What was accomplished is thus summed up: "We are now in a position to take in at a glance the complete results obtained on December 8th at our three Kerguelen stations. Of the two external contacts, the first, which from the very nature of the observation can only be a rough approximation without the aid of the spectroscope [the use of which was prevented by fleecy clouds and haze], was observed by several, and the second accurately timed by three observers. Both internal contacts were well observed by three persons, and fortunately the most important observation was also that which was best observed. The time was also taken when the centre of the planet was on the sun's limb, and though this cannot compare in accuracy with the contacts generally, it might, when estimated by a practised observer, fairly be preferred to the first external contact. Besides contacts and bisections, we obtained thirteen photographs of Venus on the sun, seven of which may be of value, and about an equal number of micrometic measurements of the distance between the limbs, with also a few diameters of the planet. We have, therefore, data sufficient for the application of the methods of both Halley and Delisle, and also for the photographic or direct method" (p. 26).

The determination of longitude detained the expedition long after the observation of the Transit. "We had never lost sight," says Mr. Perry, "of the simple though weighty instruction of Sir G. B. Airy, that 'the utmost attention must be given to the determination of absolute longitude, which will probably be fundamental for those seas.' An excellent run had been made with eight chronometers from the Cape to Kerguelen

on the voyage out, and we had already determined by gunpowder flashes the difference of local time between the English observations at Observatory Bay and Swain's Haulover and the American station at Molloy Point. Besides this, chronometer runs between the Cape and Kerguelen had been made by the *Swatara*, U.S.N., and H.M.S. *Challenger;* and the German war frigate *Gazelle* had compared chronometers with our standard clock on the occasion of her visit. But when longitudes are required correct to a second of time, much more than ordinary care must be taken" (pp. 27, 28). "The return of the *Volage* from the German station at Betsy Cove brought us to the close of the year 1874, and we still had two months to spend in the Land of Desolation before we could hope to complete the observations we had undertaken. The results required at each of the government stations differed but little, and yet there was a vast difference in the amount of necessary labour. At some places, where one cloudless night followed another in rapid succession, even the moon observations were a matter of mere ordinary routine; but when half a dozen momentary glimpses at one or other of the clock stars was the only fruit of sitting for several hours, or even for the greater part of the night, at the transit instrument, the snow often falling whilst the star was being observed, it required a strong sense of duty to keep steadily to the work" (p. 34). The final result, however, was not bad. "The moon, which had served us so hardly at first, had become somewhat more tractable, and her transit on the morning of our departure made up a total of nineteen meridian passages, which, with ninety double altitudes or azimuths and one occultation, furnish the data for our fundamental longitude. The run from the Cape to Kerguelen with eight chronometers, and the longitude connections by gunpowder flashes and chronometers, along with the latitude observations, complete the work done by our expedition for the determination of the exact position of the group of Kerguelen stations" (p. 41).

About the results of the different expeditions Mr. Perry observes:—"The accuracy of the results, and the consequent degree of approximation to the true solar distance now attained can only be correctly estimated after a most careful examination of the observations themselves; but from what we know of the extreme care taken in the longitude determinations, and of the nature of the contacts, as also of the excellence of the photographs, we may predict with confidence that the labour and expense will not have been in vain. But apart from the times of contact and the measures of the photographs, which require long and persevering labour previous to their discussion, many results have been obtained which are of value in themselves, and also from throwing light on what should be done in 1882."

Of the Black Drop he says:—"Considering the very large number of practised observers who were watching the transit with the expectation of witnessing the phenomenon, and yet could not detect the least trace, it is no slur on anyone to attribute the appearance to some peculiarity of atmospheric conditions, or of instrument, or even of a personal nature" (p. 46).

The pamphlet concludes as follows: "On reaching Malta we had finally to bid adieu to Capt. Fairfax and the officers and men of the *Volage*, from whom we had throughout the expedition received so many acts of kindness and attention, and to whom any success we may have obtained is in great measure due. A parting dinner, with the expression of the kindest wishes, and a farewell address from one of the men in the name of his companions, accompanied by a poetic effusion descriptive of the incidents of the voyage, were fresh proofs, where none were wanted,

of the generous spirit in which one and all had endeavoured to carry out perfectly the object of our expedition. H.M.S. *Volage* arrived safe at Portsmouth a few weeks later, and the results of our labours were at once deposited in the hands of the Astronomer-Royal, Sir G. B. Airy, who bore the burden of the preparations, and who is now actively superintending the reduction of the observations."

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

VENUS.

Sir,—The great northern declination of this planet during the months of May and June affords an excellent opportunity for observation.

The object of this letter is to draw attention to the singular and as yet unexplained phenomena of the occasional visibility of its unillumined hemisphere. The last transit observations are most explicit as to the appearance of a delicate ring of light round the portion of the planet that had not entered upon the disc of the sun. It is possible that this line of light may be visible when the planet is at a more distant part of its orbit. At the last meeting of the Royal Astronomical Society, Captain Noble stated that at each inferior conjunction for some years past, he has been able, by the use of a very small slip in the eye-piece, to see the whole of the disc of Venus, the unillumined portion appearing as a dark object against a lighter background. It is possible that this also may be observed when the planet is at a greater angular distance from the sun.

It is desirable that those who take an interest in this matter, should observe not only with the usual eye-piece, but with one in which the field is reduced by the insertion of a very small stop, or provided with a central dark band, so that the illumined part of the planet may be readily passed out of sight, thus enabling the eye to judge more correctly of the nature of the relief by which the remainder of the disc becomes visible. Should the appearance be that of a dark body against that of a lighter sky, then the phenomenon should be equally visible, whether on the meridian or after sunset; or on the other hand, if a faint ring of light be observed completing the form of the planet, by uniting the cusps, if visible when Venus is near the meridian it should be more clearly seen when the sun is below the horizon.

In either case this subject is worthy the most exact attention, and should the observations prove negative, they will not be without their value.

I remain, Sir, yours most respectfully,
NATH. E. GREEN.

ELECTRIC LIGHTING OF TELESCOPE CIRCLES, &c.

Sir,—I have for the last twelvemonth, by the aid of the Geissler tube and Ruhmkorff coil, been lighting up the time and declination circles, watch face, micrometer wires and finder, of my equatorial, with such great success that I feel urged to publish it, at the risk of finding that the method has already been more effectually carried out. As, however, I cannot discover that this is the case, you may, possibly, think the

matter worthy of notice. I will proceed, therefore, to explain my plans as shortly as possible, but I fear even so it will take up too much of your valuable space.

My coil in its cylinder is 9 inches long by 5½ inches in diameter, and is worked with a single cell bichromate battery carrying a zinc plate 3 inches by 5, and holding 110 ounces. This coil stands against the equatoreal pillar, south side, with the bichromate battery below. Above it, and under the time circle, is a three-way switch, by which the current may be turned three different ways. It may be termed the main switch, and is affixed to the cast-iron pillar of the equatoreal. The time circle has two-thirds round it a segment Geissler tube of Uranium glass, and between the switch and time circle is a short straight Geissler for lighting up the journeyman watch, which hangs immediately under that circle.

The declination circle has round it an entire ring of the same glass; and the tube of the telescope has fixed in it (on the same side as the finder) a straight Geissler Uranium tube lying longitudinally, about two feet from the eye end and about six inches nearer the end than one of the false light stops. (I ought to observe that my telescope is a 4½-inch, and 70-inch focus.) This stop is lined with white cardboard on the eye side for the purpose of reflecting the light into the eye-piece. There is a shield defending the eye-piece from the direct light of this Geissler tube, but it is attached to a pivot, within reach of the hand, by which this light can be made use of directly if more light be wanted. The tube of the telescope has a hole in it, opposite the centre of this Geissler, (I should here state that this Geissler has in it a volute of Uranium glass) the light of the Geissler passes through this hole and strikes a white surface set at 45° and thus it illuminates the wires of the finder.

The watch hanging close under the time circle is lighted up by the short Geissler tube before referred to, which, be it understood, is on the same circuit as the time circle tube. The main switch turns the current either into the declination circle tube, or into the time circle and watch tubes, or again into the micrometer wires tube. In the latter circuit, there is an auxiliary switch, affixed to the eye end of the telescope tube, handy to the touch, by which the micrometer wires' current may be turned, when it is required, into the Geissler ring, which lights up the two divided circles of the micrometer. One Geissler ring suffices for both circles.

My reason for not lighting up in a single circuit the watch time, and declination circles is simply that it takes a more powerful battery.

In the case of the two tubes for the micrometer, I do not light them at the same time, as the eye would be affected by the light from the ring round the position circle when looking through the telescope. There could, however, be a circular shield, but I prefer on the whole a switch arrangement. It will, of course, be necessary to be careful about the insulation, and it is recommended that the eye-pieces should be finished off with vulcanite for that part which comes nearest the eye, or one may risk a shock in the eyebrow; of a moderate character probably, as one would not be in connection with the other end of the coil. A vulcanite eye-piece holder would be equally good.

Still it is not necessary, as it is very easy to insulate thoroughly.

The zinc plate of the battery is attached to a cord running over a pulley, and is counterbalanced by a weight. One can thus in a moment put the battery in action, either partially or fully, by dropping the zinc plate into the liquid. There is also a cord attached to the contact breaker, by which the light can be stopped without lifting the zinc from the liquid. The light current can thus be broken for a few moments if

required. The other end of this cord (the loop of which may be held in the hand when observing) is attached to the upright which holds the screw for adjusting the rapidity of the beat. This upright yields a trifle, so one can vary the rate of beat without going to the coil.

In practice the zinc is dropped into the liquid, and the current is turned by aid of the main switch into the Geissler tube of the declination circle—the declination is then set off. The current is now turned into the tubes which illuminate the watch and time circle; and the right ascension is set off, and the instrument set to time. If the micrometer wires are to be lighted up, the main switch is altered to effect that purpose. The position and distance of, say, the Binary star having been taken, the observer moves the switch No. 2 (which is permanently attached to the telescope tube close to his hand), and turns the light into that tube which lights both the micrometer circles, the values of which he then reads off. If the micrometer is not in use, or the finder not required, the zinc plate is lifted out of the liquid, as it will otherwise waste.

With respect to the vibration in the light, or what is really alternately light and darkness, if the beats of the contact breaker are moderately (not very) rapid, the eye, when looking through the eye-piece, does not appreciate the break at all, and the light itself is so very mild and soft that the eye is hardly deranged by it. The hum of the beat can easily be deadened by a cover. As to the trouble of preparing the batteries, I consider it less than the usual lamp trimming—I say "the batteries" because I always keep a second battery ready for use. It will be proper here to warn those who are not accustomed to use the Ruhmkorff coil, that he will be found an awkward customer if the hands touch the two wires and so make the circuit. My plan, therefore, is to cover all the apparatus with India rubber cloth as well as the exposed points.

I fear that this description is over long, but I trust that you will permit it to appear in the *Astronomical Register*, on the plea that this method of lighting an equatoreal adds greatly both to the comfort of the observer and to rapidity in his manipulations.

I am, sir, yours faithfully,
W. E. METFORD.

Upper Redland, Bristol:
April 20, 1876.

COLOURS OF DOUBLE STARS.

During the last two years I have noted as carefully as possible the colours of most of the double stars observed by me with a six-and-a-half-inch silvered-glass reflector. The following list contains objects selected from the stars examined, which either seemed to show changes of colour in one or both of the components, or confirmed changes noted by other observers. That I might be as little biassed as possible by the recollection of the colours set down in the works I used for reference (Webb's *Celestial Objects*, and Darby's *Astronomical Observer*), I took especial care not to refer to them until after each evening's observations, and, though in a few cases—such, for instance, as η Cassiopeæ—I had a general idea of the colours I expected to see, yet in most instances I can safely say that my impressions were not influenced by any previous knowledge. I have not referred in the notes to any colours mentioned in *Celestial Objects*, as that book ought to be in the hands of every one who possesses a telescope of two inches aperture and upwards. The telescope used in making the following observations was a 6½-inch silvered-glass speculum, by Calver, of about 80 inches focus, mounted on an altazimuth stand by

Horne and Thornthwaite, and the eye-piece, an Huyghenian, by the same makers, having a measured power of 164 diameters on the 6½-inch mirror. The definition and space-penetrating powers of the speculum are admirable. With a power of 430 I have seen γ^2 Andromedæ and β Delphini in contact, and well elongated the double companion of P. xx. 178, Delphini. The minute comes to the same star, and the faint attendants of μ Andromedæ, o^1 o^2 Cygni, ϵ Trianguli; the double comes to β Equulei, and o^2 Eridani, &c., are well seen with power 164, even in bright moonlight. The power used was compared on several nights with two eye-pieces, by Browning, marked B and C, and two aplanatics of Horne and Thornthwaite's of about the same powers, and no perceptible difference in the colours of the images formed was found to exist in any way. Many of the stars noted by Admiral Smyth as distinctly white appear to have become of a decidedly yellow hue, or to be in a transition state from white to yellow, and *vice versa.* This cannot be accounted for by the different sorts of telescopes used in the observations, as many of the changes have been noted by Webb, Dembowski, and other observers, all using refractors. A Transatlantic astronomer, one of the greatest living authorities on the subject of double stars, has recently asserted that there is no instance known of a variable companion to a double star. I venture to think that this somewhat sweeping statement requires modification, for if variability in light does not go hand-in-hand with variability in colour in *every* case, it assuredly does so in a great many. It is to be hoped that so fascinating a branch of stellar astronomy will enlist many observers, and if every one who examines these twin suns, even with a small telescope, would follow Mr. Webb's excellent advice and note their colours, we should have a large series of observations to work upon.

No.	Star.	Colours of A	Colours of B	Epoch (in fractions of a year.) 187— +.
1	Antinoi, P. xx. 12.	yellowish	bluish	5·70
2	„ P. xx. 139, 140.	white	grey	5·70
3	Aquarii, τ^1	greenish white	amethyst	4·92
4	„ τ^2	orange	blue	4·92
5	„ ψ^1	orange	blue	4·92
6	„ 69 P. xxiii.	reddish white	greyish blue	4·92
7	„ 94	light orange	purplish lilac	4·92
8	„ 200 P. xxii.	yellowish white	greyish white	4·92
9	Aquilæ, π	yellow	yellow	4·57
10	„ 11	light yellow	pale blue	5·70
11	„ 57	white	pale blue	5·70
12	„ P. xix. 307.	bright white	blue	4·62, 5·63
13	Arietis, λ	yellowish white	blue, with tinge of red	4·95
14	„ 14	white	blue	4·95
15	„ 30 & P. ii. 128.	yellow	grey	4·95
16	„ 33	white, with yellow tinge	lilac or purplish	4·95
17	Boötis, ξ	yellow	garnet	5·56
18	„ π	white	white	5·56
19	Capricorni, o^2	white	bluish	5·70
20	„ ρ	yellow	flushed white	4·55
21	„ σ	yellow	violet	5·70
22	Cassiopeiæ, η	light yellow	bright purple	4·59
22	Do.	yellow	garnet	5·70
23	„ σ	greenish	blue	5·70
24	„ Σ 3057	white	grey	5·63
25	„ Σ 3062	yellow	yellow	5·63

26	Ceti, γ	very light yellow	very light blue	4·95
27	Ceti, ν	yellow	reddish lilac	4·95, 6·05
28	Cygni, o^1 o^2	colours exactly as Webb,	67, 69	5·46
29	" P. xx. 199.	blue	mauve	5·46
30	Delphini, γ	yellow	bluish	4·55
31	Equulei, P. xx. 376.	orange	light blue	4·86
32	Geminorum, γ	white, with yellow tinge	(not noted)	5·18
33	" δ	yellowish white	purple	5·18
34	" λ	white	purple	5·18
35	" 15	yellow, with reddish cast	light purplish	5·18
36	" 20	white	greenish white	5·18
37	" 61	white	(not noted)	5·18
38	" ♅ iv. 45.	(not noted)	white	5·18
39	Herculis, δ	very pale yellow	livid	5·70
40	" 60	yellowish white	(not noted)	5·70
41	Monocerotis, 11.	orange	B & C less orange	5·14
42	Ophiuchi, α	bluish yellow	(not noted)	5·70
43	" λ	white	greenish white	4·62
44	" 61	white	white	5·47
45	" 73	yellowish white	whitish	5·47
46	Orionis, 23	very light straw-colour	light blue	5·14
47	" 31	red	blue	5·14
48	" 33	very light yellowish white	very light purple	5·19
49	" 52	light yellow	light yellow	5·19
50	" Σ 712	white	pale plum-colour	5·18
51	Pegasi, κ	yellowish white	purple	5·63
52	" 3	yellowish white	flushed white	4·92
53	Piscium, α	greenish white	light fawn	4·86
54	" 42	yellow	bright green [garnet	4·92
55	Scorpionis, ξ	(not noted)	(B not noted). C light	5·47
56	Serpentis, 5	pale yellow	lilac	5·42
57	" 6	yellow	greyish blue	5·42
58	" oΣ. 308.	orange yellow	bluish	5·43
59	Trianguli, ϵ	white	(not noted)	4·86
60	" P. ii. 160.	pearly white	bluish white	4·95
61	Ursæ Majoris, α	whitish yellow	lilac	5·20
62	" ζ	white	greenish white	5·20
63	" ξ	yellow	yellow	5·19

No. NOTES.

1. Whitley, white, grey, /68·7.
3. Light yellow, pale violet, P. Sm. /56·7 Sest. white, azure, /45·8. Sm. pale white, flushed, /49·2. De. A. blanche, /63·9.
5. Sest. orange yellow, orange, /45·8. P. Sm. & Σ's colours correspond with Smyth's. Main. B. dull white, /61·8.
6. Closer than 5″·9? : Hind yellow, lilac, /46·6 : Sm. pale yellow; reddish grey, lilac, or plum, /52·8. Main, white /61, /69, /70; deep yellow, bluish, /68.
7. H. & S. ruddy, greyish, /22: Σ. alba-sub-flava, cærulea, /30·9, flava, cærulea, /36·6. Sest. orange yellow, orange, /45·8. P. Sm. yellow, light warm lilac, /56·7. Main. rose tinted, light green, /61·8.
8. Contrast certain, colours difficult. Sest. yellowish white, yellowish.
9. Divided, 80 on 6¼-in. minute cluster ± 10′ p: is the 14 mag. attendant variable? I have often found it very difficult, it is of a deep indigo blue hue.
10. A 6 m. at least; B seemed under 10 m. and showed a very sharp disc. Σ 5·7, alba subviridis, 9·2, /31·3. A. yellow, Webb, /50, /64, /65. So, De, /63.
12. B 12 mag. ±; too bright for 13 mag.

13. Sest. white, pale azure, /44·9. P. Sm. pale yellow, light lilac, /56·7 Sm. pale yellow, flushed blue, /57·7. Main. white, lilac, /63.
14. A fourth star ± 16 mag. 80° : 90″. Birmingham's comes glimpsed. Ward. 2⅞-in. Wray. Dec. /74.
15. Not 1 mag. difference. Whitley, both grey, /68 7. Main. equal, white, /63.
16. A almost as bright as μ Arietis. A white. H. & S. /22. Σ subflava, /31·7.
17. D: A white, /43·3. Hind. yellow purple, /45·3. Talmage. White, blue, /66·4. De-jaune clair, couleur de rose, /68·4. Colours vary.
20. Burnham's comes at ± 30″ 145° seen in full moonlight. Only one companion noticed to the 7.5 mag. Distance over 65″ f.
23. H & S. white, blue, /23·8. D. yellow, blue, /41·9. De. blanc, bleu-cendre: sûres. /54·8. P. Sm. pale yellow, light blue, /56·7.
25. D. white, /43·8. De. jaune clair, olivâtre, /73·6.
27. Cones certainly not less than 13m. and lilac hue most decided; it has been seen with perfect ease by Captain Noble with 4·2-in. achr. power 74; and by Mr. Ward, at Belfast, with 4·28-in. Wray, power 86.
28. Angle of o^1 323°·8, not 333°·8, as in *Celestial Objects*.
33 Another comes ± 14m., 180° 85″. Σ. 3·2 subflava, 8·2, subpurpurea, /39·72. H. & S. white, blue, /22. Hind. yellow, dusky, 4·5, 9 mag., /45·9. De. 3·5 jaune, 8·3 rouge foncé, /54·03. Webb, A, pale yellow, comes 11m. (Int. obs.).
34. Perhaps the merest yellow tinge in A. B lovely colour, resembles the hue of the companion to τ' Aquarii.
35. Forms a pretty trapezium with a 14m. and 15m. ± 60″.np.
36. Mags. as Σ /30. Sest. yellowish orange, yellow, /45·9.
37. See *Monthly Notices*, R.A.S., Vol. XXXV., No. 6, 7. A 2nd comes ± 14, 360° 65″ with a 15m. a little sp. it, and a distant 14½m. foll:
38. The star n. of the neb. H iv. 45. 2 or 3 small stars between. Can the colours have been accidently reversed in Cycle?
39 Webb. pale lemon yellow, lilac, /65·45. De. blanche, bleu clair, /69·02, /73·00. Main. straw coloured, reddish, /62.
41. A 4th star, 14 mag. or 15 mag. ± 85″ 190° Σ 5·0, 5·5, 6·0 albæ insignes. De /54·19. toutes blanches. Main. all brilliant white, /63.
43. A comes ± 15 mag. 180° 45″. A brighter one ± 160° 95″. Σ flava, subcærulea, /25—/34. De blanche, cendré, /68·95, /72·87. Engelmann. yellowish green, green, /65·53. See yellow, blue, /64·58.
44. Hardly ½ mag. diff. p. one brightest. Σ 5·5, 5·8, albæ, /27·37. Fletcher, 6, 7, yellow, /51·51. Main. 7½, 8: white, /61.
45. Closer than π Aquilæ. Σ albæ. /31·05. Fletcher, white, yellow, /51·37.
46. Sest. yellowish, bluish white, /45·9.
47. Comes 9·8 m. of Σ's scale, beautiful contrast. Buffham, /68. orange red, clear blue, 10 m. Σ.
48. H. & S. white, blue, /22·02. Σ albæ, /31·22. Main. silvery white, /62.
49. Webb's comes ± 13 m. 90″ 20°, whitish blue.
51. Comes ± 11½m. Σ 3·9 subflava 10·8, /31·56. De. 4·3 jaune clair. B 9·5—11·0, /65. Probably variable.
55. C. Violette. De. /72·80. A-B variable in colour, white and yellow.
56. P. Sm. pale yellow, warm lilac, /56·7.
57. Discovered by Burnham. Very beautiful.
58. Σ 2041.
59. Σ 5·3 egregiè alba, 11·3. /33·11.
62. Σ alba sub-virides. Sest. white, yellowish, /44·5. Main. greenish yellow, /62.

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ASTRONOMICAL OCCURRENCES FOR MAY, 1876.

DATE.			Principal Occurrences.	Jupiter's Satellites.		Meridian Passage
		h. m.			h. m. s.	h. m.
Mon	1		Sidereal Time at Mean Noon, 2h. 39m. 1·32s.	1st Ec. D. 1st Oc. R.	10 28 2 13 0	Moon. 7 4·3
Tues	2		Sun's Meridian Passage 3m. 11·45s. before Mean Noon	1st Sh. E. 1st Tr. E.	9 46 10 7	7 52·4
Wed	3	9 49	Near approach of 89 Leonis (6)	3rd Ec. D.	15 40 4	8 37·5
Thur	4	14 28	Occultation of B.A.C. 4200 (6)	2nd Sh. I. 2nd Tr. I. 2nd Sh. E. 2nd Tr. E.	12 49 13 28 15 24 15 58	9 20·8
Fri	5	12 1 13 12 17	Occultation of 50 Virginis (6) Reappearance of ditto Uranus in quadrature with Sun			10 3·6
Sat	6			2nd Oc. R.	10 3	10 47·1
Sun	7	21 52	○ Full Moon	1st Sh. I. 1st Tr. I.	14 59 15 14	11 32·2
Mon	8	20	Conjunction of Moon and Jupiter, 5° 43′ N.	1st Ec. D. 1st Oc. R.	12 21 55 14 44	12 19·4
Tues	9			1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	9 27 9 35 11 40 11 51	Jupiter. 12 31·8
Wed	10			1st Oc. R.	9 10	12 27·4
Thur	11			2nd Sh. I. 2nd Tr. I.	15 24 15 42	12 22·9
Fri	12					12 18·5
Sat	13			2nd Ec. D. 2nd Oc. R.	9 35 36 12 17	12 14·0
Sun	14			3rd Sh. I. 3rd Tr. I. 3rd Sh. E. 3rd Tr. E.	9 18 9 47 11 15 11 19	12 9·6
Mon	15		Saturn's Ring: Major axis=37″·72 Minor axis=4″·19 Illuminated portion of disc of Venus=0·440 Illuminated portion of disc of Mars=0·978	1st Ec. D.	14 15 55	12 5·1
Tues	16	1 26 23	☾ Moon's Last Quarter Occultation reappearance of B.A.C. 7835 (6½) Conjunction of Moon and Saturn 0° 13′ N.	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	11 22 11 23 13 34 13 34	12 0·7

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. Jupiter.
Wed	17	6	Opposition of Jupiter and Sun	1st Oc. D. 1st Oc. R.	8 42 10 54	11 56·2
Thur	18		Sidereal Time at Mean Noon 3h. 46m. 2·78s.	1st Tr. E. 1st Sh. E.	8 0 8 3	11 51·8
Fri	19		Sun's Meridian Passage 3m. 44·36s. before Mean Noon			11 47·3
Sat	20			2nd Oc. D. 2nd Ec. R.	12 1 14 41 37	11 42·9
Sun	21			3rd Tr. I. 3rd Sh. I. 3rd Tr. E. 3rd Sh. E.	13 2 13 16 14 38 15 14	11 38·4
Mon	22			2nd Tr. E. 2nd Sh. E.	9 35 9 51	11 34·0
Tues	23	3 25	● New Moon	1st Tr. I. 1st Sh. I. 1st Tr. E. 1st Sh. E.	13 7 13 16 15 18 15 28	11 29·5
Wed	24	17 22	Conjunction of Moon and Mercury 3° 23′ S. Conjunction of Moon and Mars 4° 2′ S.	1st Oc. D. 1st Ec. R.	10 26 12 46 12	11 25·1
Thur	25			1st Tr. E. 1st Sh. E.	9 45 9 57	11 20·6
Fri	26	5	Conjunction of Moon and Venus 1° 43′ S.			11 16·2
Sat	27	8 49 9 41	Occultation of γ Cancri (4½) Reappearance of ditto	2nd Oc. D.	14 16	11 11·8
Sun	28	8	Saturn in quadrature with Sun			11 7·3
Mon	29	17 48	☽ Moon's First Quarter	2nd Tr. I. 2nd Sh. I. 2nd Tr. E. 2nd Sh. E.	9 18 9 51 11 49 12 26	11 2·9
Tues	30			1st Tr. I. 1st Sh. I.	14 52 15 10	10 58·5
Wed	31			1st Oc. D. 1st Ec. R.	12 11 14 40 23	10 54·0
JUNE Thur	1			3rd Ec. R. 1st Tr. I. 1st Sh. I. 1st Tr. E. 1st. Sh. E.	9 16 24 9 18 9 39 11 29 11 51	10 49·6

THE PLANETS FOR MAY.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	3 15 22	N.19 21	5″·4	0 37·2
	9th	4 19 24	N.23 38	6″·1	1 8·6
	17th	5 10 41	N.25 20½	7″·2	1 28·3
	25th	5 44 57	N.25 1	8″·7	1 31·1
Venus ...	1st	5 46 19	N.26 40½	22″·4	3 6·8
	9th	6 20 47	N 26 43½	24″·6	3 9·7
	17th	6 52 34	N.26 12½	27″·1	3 9·9
	25th	7 20 41	N.25 12	30″·3	3 6·5
Jupiter ...	1st	15 48 24	S. 18 54	42″·0	13 7·3
	9th	15 44 26	S. 18 41½	42″·0	12 31·8
	17th	15 40 17	S. 18 28½	42″·0	11 56·2
	25th	15 36 8	S. 18 15½	42″·2	11 20·6
Saturn ...	1st	22 34 40	S. 10 34	14″·8	19 52·4
	9th	22 36 42	S. 10 24	15″·0	19 23·0
	17th	22 38 42	S. 10 15½	15″·2	18 53·2
	25th	22 39 44	S. 10 9½	15″·4	18 23·1
Uranus ...	4th	9 14 32	N.16 44½	4″·0	6 22·6
	20th	9 15 38	N.16 39	4″·0	5 20·8

Mercury is well situated for observation, setting an hour and a half after sunset, at the beginning of the month, the interval increasing.

Venus may be well observed, being visible at the beginning of the month for about four hours after sunset, the interval decreasing.

Jupiter rises about an hour after sunset on the 1st, and may be observed during the whole night throughout the month.

Saturn rises nearly two hours before the sun on the 1st, the interval increasing.

LUNAR OBJECTS SUITABLE FOR OBSERVATION IN MAY, 1876.

By W. R. Birt, F.R.A.S., F.M.S.

Various circumstances have prevented the completion of the list of Lunar objects for observation in May. As regards the last list Mr. Dennett has published in the *English Mechanic*, April 14, 1876, p. 117, a drawing of Fracastorius, which contains the southern margin of Mr. Simms's eastern bay. We have not been able telescopically to examine Fracastorius during the April lunation, but we hope our readers, especially those who possess large telescopes, will make a point of doing so, as should the existence of Mr. Simms's two bays be confirmed we shall have at least indications of an alteration of some kind within a recent period.

Posidonius. This formation is also one which is well worthy of further examination. We have several drawings of it, and shall be glad to receive any of recent date. We may remark that the monogram of of the Mare Serenitatis contains the outlines of Posidonius with several interior objects all numbered. May we ask observers to endeavour to identify these objects; among them will be found an interesting interior ridge, a portion of which is apparently contained as a sunken cleft—the ridge or elevated part is broken in several places, indicating a former irruption of material which has submerged portions of the ridge, if this be so, the sunken portion is of more recent origin.

NEW MINOR PLANET (161).

The following telegram was sent to the Astronomer-Royal :—

Planet Watson.

	h.	m.		°	′
R. A.	13	28	Dec. S.	11	45

Motion North, 2m. daily. 11th Mag.

Standard.

EPHEMERIS FOR PHYSICAL OBSERVATIONS OF JUPITER.

Greenwich Midnight.		Longitude of ♃'s central merid.		Angle of position of ♃'s axis.	Annual parallax.	Latitude of earth above ♃'s equator.	Latitude of sun above ♃'s equator.
1876.		°	°	°	°	°	°
May	1	316·8	870·8	12·74	−3·18		
	2	107·6	·7	12·79	2·98		
	3	258·3	·8	12·84	2·79		
	4	49·1	·7	12·89	2·59		
	5	199·8	·8	12·93	2·39	−3·23	−3·01
	6	350·6	·7	12·98	2·19		
	7	141·3	870·7	13·03	−1·99		
	8	292·0	·8	13·08	1·79		
	9	82·8	·7	13·13	1·58		
	10	233·5	·8	13·17	1·38	−3·22	−3·01
	11	24·3	·7	13·22	1·18		
	12	175·0	·7	13·27	0·97		
	13	325·7	·8	13·32	0·77		
	14	116·5	870·7	13·37	−0·57		
	15	267·2	·7	13·41	0·36	−3·21	−3·00
	16	57·9	·8	13·46	−0·16		
	17	208·7	·7	13·51	+0·05		
	18	359·4	·7	13·56	0·26		
	19	150·1	·8	13·61	0·47		
	20	300·9	·7	13·65	0·67	−3·20	−3·00
	21	91·6	870·7	13·70	+0·87		
	22	242·3	·7	13·75	1·07		
	23	33·0	·7	13·80	1·28		
	24	183·7	·7	13·85	1·48		
	25	334·4	·8	13·90	1·68	−3·18	−2·99
	26	125·2	·7	13·95	1·88		
	27	275·9	·7	13·99	2·08		
	28	66·6	870·7	14·04	+2·28		
	29	217·3	·7	14·09	2·48		
	30	8·0	·7	14·13	2·68	−3·17	−2·99
	31	158·7	·7	14·18	2·88		
June	1	309·4		14·22	3·07		

A. M.

AN ASTRONOMICAL POPE.
Sylvester II., died 12th March, 1003.

Gerbert or Gilbert, born in Auvergne of an obscure family, was distinguished for wisdom and prudence. From being monk in the Abbey of Auvillac he rose to be Archbishop of Rheims, and afterwards of Ravenna. On the death of Gregory V. Otho III. of Germany caused him to be elected Pontiff, and he assumed the name of Sylvester II. He was the first French pope, A. D. 999. Those were times of gross ignorance. Letters were studied and preserved in the cloisters; princes and gentlemen could not read or write, and despised all intellectual culture. Gilbert, a good mathematician, a philosopher and linguist, was taken for a sorcerer. He had caused to be constructed the hydraulic organs, mentioned by William of Malmsbury, which by means of water gave forth melodious notes. He set up at Magdeburg a clock with balance, by which the position of the pole star could be known. The ignorance of the times ascribed his advancement and performances to a compact with the devil, and he was said to possess in his study a brass head by which Satan replied to all his questions. It is related that in 1648 his body was discovered at S. Giovanni, in Gaterano. The urn being uncovered he was seen dressed in the pontifical robes, and with his arms folded. A pleasant odour came forth from the urn, but the corpse struck by the air was resolved into dust, and there only remained the silver cross, and the pontifical ring. Sylvester wrote six works—*On Geometry*, *On Arithmetic*, *On the Sphere*, *On the Construction of the Astrolobe*, *Dialogues*, *Epistles*. From the *Vedetta Cristiana*, Florence, May 1st. The writer of his biography in the *English Cyclopædia*, says, "There is no doubt that Gerbert was a man of great ability, and of very extensive acquirements for his age. When master of the cathedral school of Rheims, he made it one of the first in Europe, and its high character was maintained for nearly a century after his death. Geometry and astronomy were Gerbert's favourite pursuits, and he is said to have been acquainted with the Greek language."

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

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Birmingham, J.

To Dec., 1876.
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When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for the Editor are to be made payable to JOHN C. JACKSON, at Lower Clapton, London, E.

The Astronomical Register.

No. 162. JUNE. 1876.

ROYAL ASTRONOMICAL SOCIETY.

Session 1876—77.

Third Meeting of the Session, May 12th, 1876.

William Huggins, Esq., D.C.L., LL.D., F.R.S., *President*, in the Chair.

Secretaries—Mr. Dunkin and Mr. Ranyard.

The minutes of the last Meeting were read and confirmed.

Ninety-nine presents were reported as having been received since the last meeting. Mr. Ranyard drew especial attention to five volumes of sun-spot drawings, which had been presented to the Society by the Rev. Frederick Howlett. The series begins on the 18th July, 1859, and continues up to the middle of 1874. The drawings have been made with a 3-in. telescope by Dollond. On each day a drawing of the whole disc is given, showing the position of the spots, as well as beautifully finished enlarged drawings, showing the details of the principal spots and groups. Several of these drawings have already been engraved in the *Monthly Notices*, and they will form a valuable addition to the collection of sun-spot MSS. now in the possession of the Society.

The President: This present is so important that the meeting will be glad to know that the Council have passed a special vote of thanks to Mr. Howlett. (Hear, hear.)

Mr. Ranyard: We have also received, from Padre Secchi, a complete set of the Atti dell 'Accademia Pontificial de Nuovi Lincei. Some of the plates were out of print, and Padre Secchi has taken the trouble to have these reprinted for us. This series began in 1871, when the Roman Academy split into two bodies. The old Academy is now called the Reale Accademia dei Lincei, and as the adherents of the Pope would not consent to use the term Royal to their old academy, which is one of the oldest scientific societies in Europe, they formed a new body which they have called the Accademia Pontificia de' Nuovi Lincei.

Besides this we have received from Lady Herschel, the widow of Sir John, a copy of the life of Miss Caroline Herschel, handsomely bound in russia. It contains a great many letters, giving an account of Miss Herschel's life at Slough, and is a very interesting volume. The special thanks of the meeting were voted to Mr. Howlett, Padre Secchi, and Lady Herschel.

Mr. Watson was admitted a Fellow of the Society.

The President said that he regretted it was his duty, in accordance with the Bye-laws of the Society, to read the names of two gentlemen whose names have to be suspended for non-payment of arrears. The names were then read.

Mr. Dunkin read a letter from Mr. Birmingham, from which it appeared that Lohrmann's complete map of the moon—of which only four sections have been hitherto published—has lately been engraved by Herr Barth, of Leipzig, under the supervision of Dr. Schmidt, Director of the Athens Observatory, who has contributed a descriptive letterpress. The map is 3 feet in diameter.

Dr. Schmidt's own great lunar map, of 6 French feet in diameter, will soon be issued from the *atelier* of the Prussian staff, the Prussian Government having purchased it. It is the result of 34 years' labour, containing about 34,000 craters, and an equal number of hills, besides over 350 rills and other objects.

Mr. Dunkin said: I have received a paper from Mr. Burnham, which is called *A Catalogue of Red Double Stars*. It is intended to include only such stars as are not found in the revised and enlarged edition of "Schjellerup's Catalogue," and may be described as a list of double stars situated within 121° of the North Pole, where one of the components have been set down as red. Mr. Burnham remarks in a short preface to the Catalogue that the stars have chiefly been inserted on the authority of Sir John Herschel, whose partiality for red tints has long ago been remarked, and in some cases later examination by other observers has shown the colours to be much less decided, but he has thought it better to include them all.

Mr. Dunkin: I have a short note *On Coggia's Comet* from Mr. Dreyer, assistant to Lord Rosse. Mr. Dreyer was formerly engaged at Copenhagen, and these observations were made at Copenhagen before he entered the service of Lord Rosse. He has sent some sketches made with a refractor of 11 inches aperture, which will be engraved in the *Monthly Notices.* The sketches were made only on three nights, and Mr. Dreyer thinks they may be of some interest, as supplementary to the drawings in the March number of the *Monthly Notices.* On the 20th of June the nucleus of the comet was equal to a star of the 5th magnitude. The light in front of it he describes as like the top of a fountain. On the 13th of July there were two luminous tails from the coma, decidedly brighter than the region round the nucleus. On the 16th of July the comet was so near the horizon that it could not be seen very well.

Mr. Dunkin said he had a short note of his own *On the conjunction of Venus with the star* λ *Geminorum on August 17th and 18th,* 1876. He wished to draw attention to the opportunity which would then occur for making micrometrical measures between the planet and the star, the latter being of the 4—3 magnitude. A series of measures made in both hemispheres would no doubt be very important, and he hoped some measures would be obtained. The nearest approach would be visible from both North and South America, a little before sunrise, when measures might be taken without any difficulty, the altitude of Venus at this time being at Washington about 27°, and at Santiago de Chile 12°.

Mr. Dunkin said: I have another short note *On the discovery of four new planets.* The announcements seem to come faster than ever, and I suppose they will never leave off, but it is only right that each discovery should be recorded in the *Monthly Notices.* I have therefore written this short note on the four additional planets discovered since the tabulated summary in the Annual Report was prepared. Many of the planets being of the 12th magnitude leads to the supposition that the group contains an indefinite number even more minute. But so long as observers search for planets it is of importance that a current record should be made in the *Monthly Notices.* This duty naturally falls on the Secretary, and I have therefore collected together the observations of these planets made at the different European observatories up to the end of April.

Capt. Noble was called upon to read a paper entitled *Note on Dr. Royston-Pigott's Starlit Transit Eyepiece.* He said: It will be remembered that at our March meeting Dr. Royston-Pigott exhibited an eyepiece which he called a starlit transit eyepiece. It consisted in the main of a film of silver or gold ruled through

which lines were deposited upon glass; and the object of the eyepiece was to enable stars to be observed which were too faint to be perceptible when the field was illuminated as it is in the ordinary transit eyepiece. Having been favoured, through the kindness of Dr. Pigott, with one of these eyepieces, I have thought a short note of the result of the experiments which I have been able to make may not be wholly destitute of interest. I find that the mean transit of a star over mean of the five lines ruled upon the silver glass surface, differs some $\frac{3}{10}$ths or $\frac{4}{10}$ths of a second from that of its passage over or through the central line. Of course, if one were employing such an instrument differentially this $\frac{4}{10}$ths of a second might be positive in the one case and negative in the other; and if you were referring the place of an object differentially to the place of a star you might make an error of seven or $\frac{8}{10}$ths of a second. Now, I do not say that my inexperience in the use of this instrument may not have something to do with the large error I have mentioned. I believe the instrument will be valuable for some purposes, notably and particularly, under the circumstances in which Dr. Pigott intends it should be applied; that is, where you cannot illuminate the field: but according to my experience it cannot compare in accuracy with the ordinary system of spider lines lighted by a lamp through the axis of the instrument. Still, I think it may be depended upon at night and with a small star, within say something like $\frac{6}{10}$ths of a second. I can get far nearer to the truth by employing the eyepiece illegitimately, as one does an ordinary transit eyepiece—that is to say, using it in twilight, where I can see the lines; because in the dark you only see the flash, and when I can see the lines and can get a star bright enough to see through the silver film, then I can listen to the ticks of the clock and use it as I would an ordinary spider-line eyepiece; but then one does not want an eyepiece like this under those circumstances. A noticeable feature in using it is the passage of a ghost in the opposite direction through the field. I thought it might be of some interest to know the degree of accuracy of the results obtainable by this invention.

Lord Lindsay: You say there is a probable error of $\frac{4}{10}$ths of a second for each wire.

Capt. Noble: No! for the mean of the wires. It may be greater at one wire than at another You are looking for a transit, and the star flashes. You hear the tick of the clock, and it is very hard to tell the proportionate part of a second. The lines are rather wide, and I am not sure whether you do not see more than the star itself. It is a confusing observation; but taking the mean of the transit over the five lines, it will vary about three or $\frac{4}{10}$ths of a second from that over the middle one.

Lord Lindsay: Does not the sudden lighting up of the star give you a sort of shock, which puts you out?

Capt. Noble: Unquestionably; especially when the star is so small that it cannot be seen through the film. The jump quite puts one off one's guard. When the star is big enough to be seen through the film, it approaches more to the ordinary observation, but I think that is rather an illegitimate use of the eyepiece.

The President: Would you prefer to have the lines drawn narrower?

Capt. Noble: If the lines were thinner still, I think it would be an advantage; it would make the flash more instantaneous than it is. You may have the lines made so wide that you see more than the spurious disc through them. There is no doubt about the value of the instrument. I would certainly rather have it than the old ring micrometer for observing differences of Right Ascension.

Mr. Dunkin: The next paper is an important one by Mr. Hind, entitled, *On the Transit across the Sun's disc of the great Comet of* 1819. Anything coming from Mr. Hind about comets must be taken as standard. Mr. Dunkin then proceeded to read the paper, from which it appeared that the comet was not discovered till the 1st of July, 1819, at Berlin. It passed its perihelion passage on the morning of June 28, and so was consequently already receding from the sun when it first attracted attention in Europe. Olbers calculated the elements of the comet's path, and communicated his results in a letter to Bode, dated the 27th of July, and in this letter he announced his discovery of the fact that there must have been a transit of the comet across the sun's disc as it passed its ascending node early on the morning of June the 26th, two days before its arrival at perihelion, and, therefore, while astronomers were ignorant of its presence; the comet, according to his calculation, would have passed within a minute and a half of the sun's centre. In the same letter Olbers remarks on the interest that would attach to any examination of the spots on the sun's disc that might happen to have been made during the time of the transit. General Von Lindener, of Glatz, in consequence of this notice, reported to Bode, that he had looked at the sun at 5h., 6h., and 7h. on the morning of June 26th with a 2½-ft. achromatic, by Ramsden, but had found the sun to be without any spots. This statement as to the invisibility of the spots on the morning of the 26th of June was, however, contradicted by Schumacher, at Altona, and by Gruithuisen, at Munich. But the most definite observations were those of Pastorff, of Buchholtz, near Frankfort, whose sun-spot drawings and manuscripts were some years since presented to the Astronomical Society by Sir John Herschel.

Pastorff communicated his observation to the Baron de Zach in a letter dated the 25th of November, 1824, more than five years afterwards, and his drawings show a nebulous spot with a bright centre, whose position is given as 6′ 10″ from the south-east limb. Canon Stark also professed to have seen the comet at Augsburg. In his published account he said that he had seen it at 7¼h. a.m. on June the 26th, as a remarkable spot, which was neither like an opening nor a shallow, and in which there was no black depth. The spot was not well defined, and 15′ 25″ from the west limb of the sun, and 14′ 30″ from the north limb. Stark adds, that at noon—his second usual hour for observation—the spot was no longer visible.

Mr. Hind has carefully re-calculated the position of the comet, and had found that at the time of Stark's observation its calculated place would be 13′ 18″ from the sun's eastern limb, and 14′ 17″ from its southern limb, which position, compared with Stark's observation shows a difference of 2′ 49″ in R.A. and 2′ 45″ in declination. At the time of Pastorff's observation the calculated place was 2′ 32″ east of the sun's centre, and 6′ 31″ north of the sun's centre, which differs widely from the position assigned by Pastorff. Mr. Hind remarks that it seems very improbable that a comet seen in projection upon the sun's disc should present the nebulous aspect described by Pastorff or Stark. It seems far more likely that the nucleus only would be observed, and that only as a minute black spot, but Pastorff gives it with a bright nucleus.

Mr. Ranyard said: I think that the Society is much indebted to Mr. Hind for having so carefully worked up the evidence on this subject. If Pastorff's observations are to be depended upon, we shall be forced to believe that the nebulosity about the nucleus of the comet of 1819 was of much more opaque material than that which composes ordinary comets, and, what is far more difficult to understand, the nucleus appears, according to his drawing, to have been brighter than the sun itself. This is of course possible to conceive, if its brightness was caused by chemical action, but if its heat was derived directly from solar radiation, it seems something like a paradox in the theory of energy. I, for one, shall feel glad to be relieved from the necessity of believing in this observation of Pastorff's. Another point not mentioned by Mr. Hind, which seems rather to add weight to his view, is that the drawing of the comet is on the first page of Pastorff's observation book. His regular series of drawings do not begin till many years afterwards, but the few detached drawings on the first page are made in the same style and with similar measures from the sun's limb as in the latter series of drawings. This on the face of it looks a little improbable.

Mr. Christie read a note entitled *On the displacement of Lines in the Spectra of Stars.* He said that he had drawn up the note in answer to some remarks which had been made by Padre Secchi, in which he had pointed out certain discordances between the results of the spectroscopic observations made at Greenwich and those which have been published by Mr. Huggins. Mr. Christie said: I think these discordances may be readily accounted for by the fact that our early observations were affected by instrumental errors, which we consider now we have overcome. We had considerable difficulty in getting over these matters, but I need not detain you with an account of them. I have put down on the black board the stars which have been observed—twenty-one of them—and the motion obtained by Mr. Huggins, and at Greenwich; the sign — denotes that the star is approaching the earth, and the sign + that it is receding. In the numerical value, of course, we must expect a large discordance, provided we have the same sign, that is all we can hope for at present. It will be seen that in the whole list of twenty-one stars only two show discordances in the signs, viz., β Leonis and η Ursæ Majoris. In the case of some others, the results at Greenwich are hardly certain as yet, but still, as far as they go, they support the estimates given by Mr. Huggins. My point is to show that these measurements are not imaginary, though the observations are liable to large errors.

The President: It is very gratifying to me to find that the results I obtained are so far confirmed, because I put them forward at first with considerable misgiving. The line of research is a new one, and I think Mr. Christie will bear me out when I say that it is one of extreme difficulty. The chief difficulty arises from possible instrumental errors. There are several sources of instrumental errors which may produce displacements of the lines quite as large as those looked for in the star, and it requires great care indeed to be quite sure that these sources of error are absent.

Mr. Christie: I cannot sufficiently express to the meeting how much we are indebted to the President for the kindness with which he has given us the benefit of his large experience, and how many mistakes we have avoided in consequence, though still we had a great deal to learn. It has saved us a great deal of waste of time. We have made some measures of the apparent displacement of lines in the spectrum of the moon with a variety of instrumental adjustments, to show the trustworthiness of the method used. In the case of the moon there would of course be no sensible shift of the line, and any displacement must be due to the instrument or the observation.

The President asked whether they had observed any displacement in the lines of the nebulæ?

Mr. Christie: We have not attacked that question yet, but that is a field of work we propose to take up at once, and also there is the question of determining the displacement of the lines in the spectra of the planets, especially of Venus, which is in a favourable position at present.

Mr. Brett was called upon to describe some observations of his upon the distribution of light upon the disc of the planet Venus. He said: The remarks I propose to make tend to show that the surface of Venus must be in a molten or vitrified state. There are two conditions under which a spherical surface may be seen. It may be seen by specular reflection, and it may be seen by diffused reflection.

[Mr. Brett drew upon the the black board and explained that Venus being at present in quadrature, the most luminous part of the disc as seen by specular reflection should be half-way between the limb and the centre.]

If the specular reflection is perfect, no other part of the disc should be seen. What I propose to show is that such specular reflection upon Venus would be modified by the diffusion caused by an atmosphere.

[Mr. Brett then drew the appearance of Venus as seen by him shortly after quadrature, showing a brighter crescent-shaped area upon the disc, the brightest portion of which was near the centre of the illuminated part of the disc, but a little nearer to the limb than to the terminator.]

Mr. Lassell said he was far from contradicting anything that Mr. Brett had said upon this subject, but he could only say for himself that he did not see Venus as Mr. Brett had seen her, though he had looked through the same telescope, and at the same time, and under precisely the same circumstances.

The President: It must be remembered that Mr. Brett is an artist.

Mr. Christie: I have no pretensions to be an artist, but some two years ago I examined Venus, in order to see if there were any marks upon her. At that time she was a little past quadrature, and in something of a crescent-shape, and there was certainly a gradation of light towards the terminator. Indeed it was very marked. I noticed it then without any idea that it had any special reference to any theory, but simply as a matter of fact, so perhaps my testimony may be of the more value. To my eye it shaded off most gradually. I also saw the same appearance as regards the cusps as Mr. Brett has drawn.

Mr. Lassell described on the black board the markings he had seen.

Mr. Green : I have observed Venus every evening lately, especially with regard to the visibility of the dark part of the disc. I will not say that the bright area described by Mr. Brett was not there, but, if it was, it was an exceedingly delicate marking, for I have not noticed it; but I have observed the brilliance of the cusps; it was so great as to give the idea that there must be polar snows, as on Mars. With regard to the condition of the surface of Venus, I think we may very well compare it with the lunar surface. Surely, at quadrature, especially if the moon be seen by early daylight, or before it is dark, there is just the same appearance on the limb of the moon, the portion towards the limb is very much brighter than the shaded part towards the terminator. If Venus is in a vitreous state, perhaps the moon is so also. But with regard to the brilliant point, I will look out for it most carefully.

Mr. Ranyard : I think we are not forced into Mr. Brett's conclusion that if there is specular reflection from the surface of the planet, it is necessarily vitrified or molten. There is a certain amount of specular reflection from almost everything. If you observe trees, or a grass field with a Savart's polariscope, lines will be seen indicating that the component in the plane of reflection is rather greater than the component at right angles to it. There is hardly any surface I know except a heap of white flour, that will not give lines when examined with a Savart's polariscope. I have no doubt that terrestrial landscape, and the ocean as seen from a distance, would show comparatively strong traces of specular reflection, but I do not understand how the specular reflection theory can produce the crescent form described by Mr. Brett. One would expect to find a small symmetrical spot of light towards the centre of the illuminated disc, and not near the cusps.

The President : A few days ago Mr. Brett told me what he had seen in Venus, and I looked back at some careful drawings I made of Venus some five or six years ago, when I first had the 15 inch refractor. I remembered distinctly having seen a certain portion of Venus brighter than the rest. I thought it might happen that I had seen it brighter in the particular place indicated by Mr. Brett; but the parts I had marked as brightest did not agree with those seen by Mr. Brett. The general aspect of the planet was similar to that described by Mr. Lassell.

Mr. Knobel : A few years ago Mr. Browning showed me a drawing with a spot on it, precisely in the position the President has pointed out, which he said was decidedly the brightest spot.

Mr. Ranyard : It will be very easy to test Mr. Brett's specular reflection theory by observing Venus with the polariscope.

Mr. Brett: Mr. Green has quite confirmed my impressions. He has assured you that the corrugated surface of the moon is brightest at the limb. If the surface had been covered with crystals, it would be a much more satisfactory instance of diffused reflection. The drift of my remarks is that the brightest point of Venus differs from that of the moon as it is *not* on the limb at quadrature.

The Rev. Mr. Howlett was called upon to describe the sun-spot drawings which he had given to the Society. He said: My remarks will be very few. This is certainly one of the happiest moments I have ever experienced since I became a fellow of the Astronomical Society. I feel infinitely gratified by the very kind way in which my present has been received to-night. These drawings extend over seventeen years. I have not deduced any theory from this wonderful array of spots: I leave that to abler hands. I hope and trust that these volumes of spots will be studied by gentlemen interested in the subject. It will be seen there is a very remarkable typical variety in the spots. We are all familiar with the wonderful group, or series of spots, wherein Mr. Carrington and Mr. Hodgson saw that remarkable outburst in August or September, 1859. Since then there never has been any group of spots in the slightest degree like them, and they possess quite a character and form of their own. I think it will be seen that there are totally distinct types of spots at different periods. Many of them possess a form so peculiar that it will be a matter worthy of study and research as to what may or may not depend on those forms. I had always intended that this result of my labours should be placed at the disposal of this Society, and I feel deeply honoured by the manner in which the Society has accepted the books. Three of the five volumes will be found to be drawn all on the same scale. The earlier volumes were not always exactly on the same scale. As soon as they were drawn from the telescope by projection, they were gummed down on the sheets in the volumes. It must not be understood that there is any sort of after touching about the drawings. I find that the same spot drawings in the possession of the Society commence in 1819, and that they extend to 1837, when there is a *lacuna* of about nine years from 1837 to 1846; and then again the drawings appear to be deficient from 1849 to 1859. I am not quite aware when Mr. Carrington's series commences. Mine commences with 1859, and for the eleven years' period the observations were carried on systematically with many hundreds of drawings, but from that time to this they have only been drawn at intervals when anything unusual stirred me up to draw them again. It would be very desirable to secure a continuous series of solar drawings.

Mr. Ranyard asked whether Mr. Howlett had in any cases marked the position of the north point upon the drawings, or whether there was any means of determining the position of the Sun's axis.

Mr. Howlett: I have a method for approximately determining these points. When I wanted particularly the true position of north and south, I used to take the same spot at the same minute for several days.

The President: It would add greatly to the value of the books if Mr. Howlett would write an introduction to them, stating the method by which the positions of the spots were laid down.

Mr. Whipple: I should not like this occasion to pass without reminding the Society that they possess a series of records which cover all the intervals that Mr. Howlett has named. The Society possesses a magnificent series of manuscript drawings by the late Hofrath Schawbe, which are now at the Kew Observatory. They extend in an unbroken series, I think, from 1825 up to 1867. Many of them, I believe, resemble those drawn by Mr. Howlett, and others are drawn on a key chart, which would doubtless fill up any information wanted.

Capt. Noble asked the object of the drawings having been made on tracing paper.

Mr. Howlett said that the spots were delineated exactly as projected on the screen, but their position was then reversed, and, by turning the tracing paper over on the sheet, the object was brought to its correct position at once. (Hear, hear.)

Capt. Noble: Some years ago, at the instigation of Mr. Carrington, I made a series of drawings of sun spots, duplicates of which I sent to him. I have seen copies of some of Mr. Howlett's, and, on comparing them, the agreement is something marvellous.

The President: I am sure we are much obliged to Mr. Howlett for his information. (Hear, hear.)

A paper by Dr. Robinson was read *On the relative powers of achromatic and reflecting telescopes,* in which he endeavoured to compare the relative merits of the two forms of instruments. If one of two equally luminous telescopes shows a faint object better than the other, this can only arise from the first condensing its light into a smaller image. In this respect the achromatic presents greater difficulties than its rival. It has two aberrations to be corrected, chromatic and spherical—of which the first is never completely destroyed, and the second requires the careful figuring and centreing of four surfaces, and defect of homogeneity in its glasses disturbs the image; defective annealing, from which scarcely any large lenses are free, tends to produce diffusion, and

the same mischief may arise from strain caused by pressure on its supports. On the other hand, a speculum has only one surface to be figured. But it is very sensitive to irregular pressure; this has, however, been greatly remedied by the system of supporting levers invented by Grubb and Lassell. Dr. Robinson then proceeded to compare the power of the great achromatics and reflectors, and comes to the conclusion that the evidence of the inferiority of reflectors is very inconclusive.

Lord Lindsay: I think I heard a passage in the paper in which it was said that the satellites of Uranus were never seen with a telescope under 11-inches.

Mr. Dunkin: I think that was in reference only to the two inner satellites.

Capt. Noble: Dr. Robinson has only to go to Mr. Ward, of Belfast, and he will show him the satellities of Uranus with an achromatic of $4\frac{3}{10}$-inches aperture.

Mr. Lassell: I do not think there is any evidence except Mr. Ward's of seeing them with less than an 8-inch achromatic. I should like to say a word about the tarnish which Dr. Robinson speaks of as one of the greatest obstacles to the manufacturer of reflectors. I venture to say there is no great danger of tarnish with proper care, at the same time it must be remembered that there is such a thing as tarnishing of the surface of the flint lens of an achromatic glass. I have not been very careful in shutting up my speculum in any air-tight cover. All I use is a loosely-fitting tin cover, and though I have had it for many years, there is no perceptible tarnish whatever, even on the small speculum, which is much more exposed. I do not use any tight-fitting cover, but merely a plate of tin, which slides over the surface, but does not touch it. That is sufficient to keep the hygromatic effect of damp, condensation, and evaporation from acting upon the surface, so that I think if the alloy of the metals is properly compounded there is no danger whatever in tarnish. I should say that in the mirror of the $7\frac{1}{2}$-inch telescope, which has not been touched for 15 years, there is no perceptible depreciation of lustre.

The President: I am sure the Society will be glad to receive a communication from so honoured a Fellow as Dr. Robinson. It is pleasant to find evidence of the continued lively interest he feels in the Society. I had the privilege of seeing the speculum to which Mr. Lassell has referred, and certainly the polish was as perfect as the day when it was finished.

The President: I have had an opportunity also of seeing Mr. Lassell's 2 ft. reflector, and comparing it with my 15-in. refractor, and my impression was that the 15-in approached the 2-ft. in effective power, but that the 2-ft. was superior in light, the 15-in. approached it very nearly.

Mr. Neison read a paper *On the satellites of Uranus,* and a paper by Mr. Rogerson *On the visibility of Oberon and Titania* was read by Mr. Dunkin.

The following papers were also taken as read:

Dr. Berg: *On Precession.*

E. Stephan: *Observations of Minor Planets made at the Observatory of Marseilles.*

Major H. S. Palmer: *On recent American determinations of geographical positions in the West Indies and Central America.*

J. Ennis: *On our sidereal system and the direction and distance to its centre.*

The President: I will ask you to return thanks to the authors of these papers. The meeting is now adjourned to June 9th.

REVIEWS.

How to keep the Clock right by observations of the fixed Stars with a small fixed Telescope: together with Tables of Stars, arranged to show, by the use of a little arithmetic, the mean solar time of their apparent Transits, to the end of the Century. By Thomas Warner. Improved Edition. London: Williams and Norgate.

The telescope figured and described in this work has a 2-inch objective, focal length 30-inches. Though fixed in its cradle to a star pillar, the sliding eye-piece enables a vertical range of three degrees to be measured, so as to show the declinations of the stars with sufficient accuracy to identify them. During the year a zone of 0h. to 24h. R.A. and 50 to 53 degrees N.P.D. passes the field of view. In this zone the positions of 1644 (?) stars to the 8th magnitude inclusive for the epoch 1st January, 1875, with their annual and season variations in R.A. and N.P.D., are given from the best tables. A spirit level, specially adapted for the purpose, measures the amount of error that it may be allowed for. There is also a contrivance for illuminating the field of the telescope sufficiently to see the wires.

When the telescope is fixed so as to show the zone of stars (which must be rather a troublesome operation), and the wires fixed at right angles to the path of the stars, the error of the instrument has first of all to be found by a trustworthy watch or chronometer, comparing the time at which a star is observed to pass the wires, with the time the star should cross the meridian according to the tables. This error is constant, and when combined with the mean solar time of the apparent transit formed from the tables, will give the mean solar time of the stars *passing the telescope*; which, compared with the observed times, gives the error of the watch or clock. Explicit directions and examples illustrate all this. After a description of the instrument, the author says, "Such is the fixed telescope, admitting, no doubt, of increased simplicity in construction, but, even as it is, very simple. It has no working parts to affect the accuracy of the observations taken with it, and it is not likely to be disarranged by unskilful usage. *It will not find the time,* but the time having been once found, I believe it will *keep* it in a very satisfactory manner; and though it may take something from astronomy, and give

little in return, it is calculated to be of no small service to horology. The tables of stars to be observed with it have been carefully prepared from several catalogues, including the best, and have been arranged so as to be readily used by those who are not astronomers, and whose accquaintance with mathematics is limited to the knowledge of a little arithmetic. With these facilities for reducing the observations of the fixed stars to mean solar time, is it too much to hope that others may improve upon the instrument?"

We hope that Mr. Warner's contrivance will become popular. He has evidently taken much pains to obviate possible derangements in the instrument, and a great deal of trouble with the tables, the printing of which is excellent. Even observers provided with transit instrument or sextant might sometimes find Mr. Warner's instrument useful as a quick and ready check upon the clock-rate, when extremest accuracy is not required. Of the cost of the instrument—made by Troughton & Simms—in its present state, we are not informed. We should be rejoiced to find that it can be made for a moderate sum, so as to bring it within the reach of many who would be glad to keep their clocks right without much expenditure of money, time, and trouble. The author appends letters of cordial approval which he received from Professor Challis, Cambridge, and the late Sir John Herschel.

Physical Geography: or the Terraqueous Globe and its Phenomena. By William Desborough Cooley. London: Dulau and Co.

We notice this work because of its admirable chapters on astronomy, of which there are five, and one towards the end of the work treating on past changes of climate, which are discussed in connection with changes in the excentricity of the earth's orbit, and the resulting production of "Glacial Periods." The work opens with an account of the Solar System, the measure of Gravitation and nature of Parallax, and passes on to a consideration of the fixed stars and nebulæ. The second and third chapters treat of the figure and motions of the earth, the methods of determining its figure, including accounts of various geodelic surveys in France, Great Britain, India, Russia, &c.; also its density. The fourth chapter treats of the methods of determining the positions of places on, and representations of, the earth's surface; and the sixth chapter refers principally to the astronomical causes of heat, the effect of the sun's declination in producing variations in the length of the day, the distribution on the surface of solar heat; and thus passes from astronomy to meteorology. This branch, however, although well treated, is beyond our province to notice. We may, however, remark that the illustrations consist of twelve well executed maps and numerous wood engravings referring both to the astronomical and other portions of the work. Readers who are interested in meteorology will find in the maps much information as to the distribution of heat in the isothermals, of pressure in the isoharies; also of wind, rain currents, &c. We strongly recommend a careful perusal of this interesting book, which ought to find a place in every astronomical and meteorological library.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

VENUS AND URANUS.

Sir,—My friend Mr. Green has drawn the attention of the Royal Astronomical Society to the visibility of the unilluminated portion of the disc of Venus, and has alluded to me as one of its observers.

I have frequently, indeed almost as often as I have viewed the planet, seen it from quadrature to the inferior conjunction in the daylight. On Sept. 28, 1863, a few hours from the inferior conjunction, Venus being 7° S. ☉'s illuminated disc 0·58, it was very visible, and on Sept. 20, 1866, 2 p.m., being then about quadrature, I showed the planet to a lady who had not previously seen it, and she immediately remarked that she saw the whole disc, which, not supposing that it could be then seen, I verified by my own observation, and in both cases it was equally well seen.

I have several very carefully made drawings of the phenomena in question, but in all of these the dark portion is represented as projected upon a ground a shade darker and more blue, and herein my drawings seem to differ from those of other observers. I have never, till a few nights ago, used a limiting diaphragm, and the powers best with an o. g. $3\frac{8}{10}$, 65in. focal length, were 76 and 120. On the 10th inst., 9 p.m., I saw the dark part of the disc but very imperfectly, although better without than with a dark band, which rather distressed my eye than otherwise.

The visibility of the outer satellites of Uranus, with instruments of small aperture, was likewise noticed at the last meetings of the Society, and I may be permitted to add that with the telescope used above—a Tully used for many years by the Rev. T. W. Webb—I believe that I have seen Oberon several times. In 1866, with what data were available, I projected a diagram of the apparent orbit of the outer satellites, then nearly circular, on which I jotted the computed place of Oberon, and made a limiting diaphragm reducing the field to its orbit, and on bringing the planet just to the edge of it, saw on five occasions in January a minute point of light very distinctly, on four out of the five times in or near the assumed place.

On January 20th, 1866, my notes are: air damp, incipient fog, with 130, distinctly; colour, very pale blue; different from other minute stars in the field, and very near computed place.

Mr. Lassell, and subsequently Mr. Marth, kindly furnished, in the March following, more accurate and fuller data of the orbits and places of the satellites, and the places of Oberon deduced from these agreed fairly well with those I had noted.

I may add that I have the gift of a singularly good eye, which is perhaps a greater advantage than is sometimes thought, and with a very excellent Dollond, of only $2\frac{1}{8}$ inches aperture, 44 inch focal length, I saw the shadow of Titan upon Saturn, June 2nd, 10 p.m., 1862, perfectly well, which Mr. Dawes *only thought* might be observed with 4 inch aperture at the least.

I can even now, by covering the surrounding sky with my hand, reduce Jupiter and Venus to a neat sharp disc, and formerly had no difficulty in seeing the pair of stars ε Lyræ.

Some of your readers will doubtless say that the above are altogether

optical illusions. But, dear Mr. Editor, it is difficult to disbelieve the evidence of the senses, and I am irresistibly reminded of a dispute between two Frenchmen when travelling abroad. One narrated what he had seen of the fatal effects of a snake bite in Cayenne (I believe) which his adversary, a very learned man, but who had never been out of France, maintained was *impossible*, and I am almost ashamed to confess, Sir, that I, when appealed to as umpire, decided in favour of him who only had used his *eyes*.

Ealing: May 15, 1876. I am, Sir, yours respectfully,
W. L. BANKS.

THE METEOR OF SEPT. 24, 1875.

Sir,—In the *Astronomical Register* for April, in Capt. Tupman's paper on the Meteors of last Sept., I see it mentioned that an observer in Bath heard a "slight continued hissing as the meteor of Sept. 14 rushed through the air." I saw the meteor, but I failed to notice any sound at all. I was walking along a road in direction a little W. of N., and saw the meteor slowly descending from N. towards W. I was unable to observe its direction with any accuracy, owing to the business I had in hand at the moment, or I should have sent a notice of it to your paper. Of course I do not pretend to say positively that there was *no* hissing sound, but I certainly did not hear it, and I *think* I should have done so had there been any. I know from experience how much imagination has to do with these things with those who are not accustomed to observe astronomical phenomena. The majority of people believe that there is always a sound heard with these fire-balls.

Bath. P. B.

COGGIA'S COMET.

Sir,—In the fifth number of Vol. 36 of the *Monthly Notices* of the Royal Astronomical Society, that is to say, the number for March of the present year, there are contained three beautifully executed engravings of Coggia's comet, as seen in July, 1874. One of them is from a sketch from Mr. G. H. With, and two are from drawings taken by Mrs. Newall.

That representations of a comet taken with instruments of a different size, and more especially on different nights should vary considerably may be expected naturally enough. On the present occasion, however, it so happens that a sketch of the comet in question was taken by these two observers, not only on the same night, but almost at the very same hour.

On that evening, July 14, Mr. With, as he informs us, made use of an "8½-inch speculum," yet with this comparatively small instrument he on that occasion saw the brilliant fan of light, of which the sketch taken by Mrs. Newall on the same night, and all but simultaneously, can hardly be said to exhibit a faint image.

One of the peculiarities, moreover, of Mr. With's drawing is the remarkable brilliance of the *outer edge* of the fan, and of this there is not a trace in Mrs. Newall's sketch, with respect to which, Mr. Newall remarks, that it was so exact he did not correct it at all. How is it that Mr. Newall's giant appears to have seen so little of what Mr. With's dwarf seems to have perceived so clearly?

Lonsdale Road, Barnes: I am, Sir, yours truly,
May 8, 1876. EDWARD B. JONES.

OBSERVING WEATHER AND METEORS.

Sir,—In the *Register* for August, 1871, there is a list of clear nights for observation noticed by me in South Lancashire, &c. By clear nights I understand that the sky should be quite clear or with only a few very small passing clouds till about 11h., or else thoroughly clear for a full hour. I have kept a list of clear evenings in my note-book since 1859. If the sky has not been cloudless for one hour for a particular evening, I have not marked that one as clear. Of course this does not give any idea of the state of the sky after midnight, when, according to some observers more distinct definition is obtained than before.

Continuing the record from 1870, I found—

In 1871	...	98	evenings	clear,	partly or	throughout.
1872	...	90	"	"	"	"
1873	...	82	"	"	"	"
1874	...	113	"	"	"	"
1875	...	100	"	"	"	"

These figures show nearly double the number of available evenings here than I experienced in South Lancashire. I do not, however, consider any part of Devon as a superior atmosphere in England for observation. Some of the Midland counties, especially Notts and Herts, would probably be found to experience the largest number of clear nights. Such records would be useful, not only as indicating the best locality for a very large instrument, but also for those who have a wish to see "Venus in sole" on Dec. 6, 1882, and who do not care to take a trip across the Atlantic for that purpose. The last two years the sky was perfectly overcast here on the afternoon of that day. West Cornwall, where the transit would be seen a few minutes longer than anywhere else in England, is, I have been informed, generally cloudy before sunset at that time of the year. In the present year I found the following clear nights in January: 1st, 6th (after 10h.), 11th, 12th (till after 10h.), 18th (till 7½h.), 22nd (after 9h.), 24th (after 7h.), 25th. Nights partly clear, *i.e.*, with more or less blue sky. 9th, 16th 19th, 21st, 23rd 26th.

February. Clear nights: 2nd (except about 8h.), 4th, 5th (till 9h.), 15th, 22nd (till 10h., but windy), 23rd (till 7½h., but windy), 27th (except about 9h.) 29th (till 9h.). Nights pretty clear: 3rd, 6th, 9th, 13th, 21st.

March. Clear: 1st (a few clouds), 4th (till 10h.) 17th, 22nd (after 10h.) 23rd, 24th (except from 9h. to 11h.) Partly clear: 3rd, 6th, 7th, 9th, 10th, 12th 15th 16th, 18th, 20th, 25th, 29th, 30th, 31st.

I have always included windy nights, as though useless for double star measurements, certain rough observations may be taken, as, *e.g.*, meteors.

Possibly some of your readers may have noticed the brilliant meteor of Feb. 13th. At 7h. 8·9m. on turning my eyes from Venus, I witnessed a meteor of precisely the same apparent magnitude and brilliance, but greenish. Course from β Leporis downwards to 3° beyond ϵ.

Upton Helions Rectory, Devon: April 5.

Faithfully yours,
SAMUEL J. JOHNSON.

A TERCENTENARY.

On the 23rd of May, 1576, King Frederic II. of Denmark signed the decree by which he granted the island of Huenen to Tycho Brahe for life. On the 8th of August the foundation stone of the castle of Uranienborg was laid, and on the 14th of December, 1576, Tycho made his first

astronomical observation there. The best available source for gaining a good notion of Tycho's island, observatories, and instruments, is to be found in the first volume of T. Blaeu's "Atlas Major," (1662) or his "Grand Atlas," (Amsterdam, 1667), in which not less than fifteen plates (five being double folio) are devoted to them. Both editions of the Atlas are in the British Museum, and the French edition is also in the Admiralty Library, so that readers in town, who care for historical reminisences of astronomical science, have an opportunity of getting considerable information about the grand abode of the "instaurator astronomiæ," and of appreciating the better Tycho's own reflection after he had left it :—

> "Uraniæ sacrata domus, specula inclyta coeli,
> Excelso fundata loco, firmataque vallis,
> Arboribusque herbisque tuis circumsita in hortis,
> Quæ ter septenos lustrast cuncta per annos
> Sidera, dum caput augustum sustollis Olympo :
> Siccine spreta jaces ? Sic nunc orbata quiescis ?
> * * * * * ."

Of the ruins of Uranienborg and Stjerneborg, as they appeared in the summer of 1868, D'Arrest has given a very interesting account in No. 1718 of the *Astronomische Nachrichten.*

A. M.

SATELLITES OF SATURN.

The opportunities which the possessors of powerful telescopes have had last year of making valuable contributions towards our better knowledge of the motions of the satellites, by watching their passing the direction of the minor axis of the ring, and by noting the times of such passings, appear to have been entirely neglected. Of the long list of predicted conjunctions not one seems to have been observed. Yet the result of every carefully observed conjunction would have vied in importance with the best micrometrical measurements, and would have been worth half-a-dozen indifferent ones.

The apparent orbits of the satellites nearer to the planet than Rhea have since become so contracted that the conjunctions with the centre of the planet are not longer observable. Telescopes of sufficient power ought now to be employed in fixing the times when the satellites are in conjunction with the ends of the ring, and with the limbs of the ball. If the occurrences of these conjunctions are approximately known beforehand, the task of observing them involves very little trouble beyond the exercise of some patience. It remains to be seen whether the possessors of the instruments required can be induced to assist with them in the pleasant and grateful task of gathering valuable fruits just ripe for plucking, or whether they will continue to deserve the reproach of leaving ripe fruit unplucked, even when they are relieved of all preliminary trouble.

The following list contains the approximate Greenwich sidereal times of the conjunctions of the satellites with the ends of the ring, and also of their greatest elongations, which occur between 16h. and 4h. Greenwich sidereal time. In the case of Mimas the times of the elongations only are given and these may possibly be more than two hours too early, as no observation of the satellite of last year has become known.

Abbreviations :—

nf.	Satellite north of ring, in conj. with	following	edge of ring, going	out.
np.	„ „ „ „	preceding	„ „	in.
sf.	„ south „ „	following	„ „	in.
sp.	„ „ „ „	preceding	„ „	out.
e.	„ at greatest Eastern elongation.			
w.	„ „ Western „			
inf.	„ at inferior conjunction with the centre of ball, South.			
sup.	„ at superior „ „ „ North.			

1876.	Gn. Sid. Time. h		
June 20	16·3	Rhea.	nf.
	17·7	Encel.	nf.
	17·7	Mim.	w.
	19·0	Tethys.	np.
	20·0	Dione.	w.
	22·7	Encel.	e.
	2·0	Tethys.	nf.
	3·8	Encel.	sf.
21	16·3	Dione.	nf.
	16·4	Mim.	w.
	17·7	Tethys.	sf.
	20·3	Encel.	np.
	0·7	Tethys.	sp.
	2·7	Encel.	nf.
	3·7	Mim.	e.
22	16·5	Tethys.	np.
	17·5	Dione.	sf.
	18·2	Rhea.	inf.
	19·1	Encel.	sp.
	22·7	Rhea.	sp.
	23·4	Tethys.	nf.
	0·2	Dione.	sp.
	2·4	Mim.	e.
23	16·7	Encel.	e.
	21·3	Rhea.	w.
	21·7	Encel.	sf.
	22·1	Tethys.	sp.
	1·1	Mim.	e.
	2·4	Dione.	np.
24	20·0	Rhea.	np.
	20·6	Encel.	nf.
	20·8	Dione.	e.
	22·8	Tethys.	nf.
	23·8	Mim.	e.
	0·5	Rhea.	sup.
	1·6	Encel.	e.
25	18·1	Encel.	w.
	19·1	Dione.	sp.
	19·5	Tethys.	sp.
	22·5	Mim.	e.
	23·2	Encel.	np.
	3·4	Tethys.	w.
	3·7	Rhea.	e.

1876.	Gn. Sid. Time. h		
26	18·2	Tethys.	nf.
	20·3	Dione.	np.
	21·1	Mim.	e.
	22·1	Encel.	sp.
	2·1	Tethys.	e.
	2·3	Rhea.	sf.
	3·1	Encel.	w.
	4·0	Dione.	nf.
27	16·6	Dione.	e.
	17·0	Tethys.	np.
	19·6	Encel.	e.
	19·8	Mim.	e.
	0·6	Encel.	sf.
	0·8	Tethys.	w.
28	17·1	Encel.	np.
	18·5	Mim.	e.
	23·5	Encel.	nf.
	23·6	Tethys.	e.
	1·6	Dione.	w.
	4·6	Encel.	e.
29	16·0	Encel.	sp.
	17·2	Mim.	e.
	17·7	Rhea.	nf.
	21·0	Encel.	w.
	21·9	Dione.	nf.
	22·3	Tethys.	w.
	2·1	Encel.	np.
30	16·4	Rhea.	e.
	18·6	Encel.	sf.
	21·0	Tethys.	e.
	23·1	Dione.	sf.
	1·0	Encel.	sp.
	3·2	Mim.	w.
July 1	17·5	Encel.	nf.
	19·4	Dione.	w.
	19·6	Rhea.	inf.
	19·7	Tethys.	w.
	22·5	Encel.	e.
	0·1	Rhea.	sp.
	1·9	Mim.	w
	3·6	Encel.	sf.
	3·6	Tethys	np.

A. MARTH.

ASTRONOMICAL OCCURRENCES FOR JUNE, 1876.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Jupiter.
Thur	1		Sidereal Time at Mean Noon, 4h. 41m. 14·59s.	3rd Ec. R. 1st Tr. I. 1st Sh. I. 1st Tr. E. 1st. Sh. E.	9 16 24 9 18 9 39 11 29 11 51	10 49·6
Fri	2		Sun's Meridian Passage 2m. 13·41s. before Mean Noon	1st Ec. R.	9 8 58	10 45·2
Sat	3					10 40·8
Sun	4	20	Conjunction of Moon and Jupiter, 5° 34′ N. Saturn's Ring: Major axis=39″·02 Minor axis=4″·14			10 36·4
Mon	5	8 41 9 47	Occultation of B.A.C. 5347 (5) Reappearance of ditto	2nd Tr. I. 2nd Sh. I. 1st Tr. E.	11 32 12 26 14 4	10 32·0
Tues	6	12 37 18	○ Full Moon Venus at greatest brilliancy			10 27·6
Wed	7			2nd Ec. R. 1st Oc. D.	9 11 58 13 55	10 23·3
Thur	8			3rd Oc. D. 1st Tr. I. 3rd Oc. R. 3rd Ec. D. 1st Sh. I. 1st Tr. E. 3rd Ec. R.	9 25 11 3 11 9 11 30 50 11 33 13 14 13 15 14	10 18·9
Fri	9			1st Oc. D. 1st Ec. R.	8 21 11 3 16	10 14·5
Sat	10			1st Sh. E.	8 14	10 10·2
Sun	11					10 5·8
Mon	12			2nd Tr. I.	13 48	10 1·5
Tues	13	8	Conjunction of Moon and Saturn 0° 15′ S.			9 57·1
Wed	14	15 14	☾ Moon's Last Quarter	2nd Ec. R.	11 48 27	9 57·8
Thur	15	14	Inferior conjunction of Mercury and Sun Illuminated portion of disc of Venus=0·199 Illuminated portion of disc of Mars=0·990	3rd Oc. D. 1st Tr. I. 1st Sh. I.	12 46 12 48 13 28	9 48·5

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Fri	16		Sidereal Time at Mean Noon, 5h. 40m. 22·97s.	1st Oc. D. 1st Ec. R.	10 7 12 57 40	9 44·2
Sat	17		Sun's Meridian Passage 0m. 40·46s. after Mean Noon	1st Tr. E. 1st Sh. E.	9 27 10 10	9 39·9
Sun	18					9 35·6
Mon	19					9 31·3
Tues	20	22	Conjunction of Moon and Mercury 9° 28′ S.			9 27·1
Wed	21	10 16	● New Moon	2nd Oc. D.	10 17	9 22·8
Thur	22	12	Conjunction of Moon and Mars 3° 31′ S.			9 18·6
Fri	23	7	Conjunction of Moon and Venus 4° 40′ S.	2nd Sh. E. 1st Oc. D.	9 28 11 53	9 14·3
Sat	24	8 56 9 19	Occultation of 83 Cancri (6) Reappearance of ditto Saturn's Ring: Major axis=40″·36 Minor axis=4″·29	1st Tr. I. 1st Sh. I. 1st Tr. E. 1st Sh. E.	9 2 9 52 11 14 12 4	9 10·1
Sun	25			1st Ec. R.	9 20 44	9 5·9
Mon	26			3rd Sh. I. 3rd Sh. E.	9 10 11 10	9 1·7
Tues	27					8 57·5
Wed	28	3 13	☽ Moon's First Quarter	2nd Oc. D.	12 39	8 53·3
Thur	29	8 21 9 36	Occultation of *i* Virginis (6) Reappearance of ditto			8 49·1
Fri	30	9 25 10 41 11 51	Occultation of B.A.C. 4722 (6) Reappearance of ditto Occultation of B.A.C. 4739 (6½)	2nd Sh. I. 2nd Tr. E. 2nd Sh. E.	9 27 10 8 12 3	8 44·9
JULY Sat	1	21	Conjunction of Moon and Jupiter 5° 32′ N.	1st Tr. I. 1st Sh. I. 1st Tr. E.	10 50 11 46 13 2	8 40·8

THE PLANETS FOR JUNE.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	5 58 12	N.23 39	10″·4	1 16·7
	9th	5 53 46	N.21 27	11″·8	0 40·9
	17th	5 31 52	N.19 3½	11″·9	23 45·8
	25th	5 22 26	N.18 36	10″·6	23 2·8
Venus ...	1st	7 41 19	N.24 1¼	33″·4	2 59·6
	9th	7 59 1	N.22 27¾	38″·0	2 45·8
	17th	8 8 52	N.20 49	43″·2	2 24·1
	25th	8 9 9	N.19 15½	48″·8	1 53·0
Jupiter ...	1st	15 32 39	S. 18 4	42″·0	10 49·6
	9th	15 28 59	S. 17 52½	41″·8	10 14·5
	17th	15 25 48	S. 17 43	41″·0	9 39·9
	25th	15 23 13	S. 17 35	40″·4	9 5·9
Saturn ...	1st	22 40 36	S. 10 6	15″·6	17 56·4
	9th	22 41 14	S. 10 4	15″·8	17 25·6
	17th	22 41 29	S. 10 5	16″·0	16 54·4
	25th	22 41 19	S. 10 8	16″·2	16 22·8
Uranus ...	1st	9 17 1	N.16 32½	4″·0	4 35·0

Mercury may be observed for about an hour and a quarter after sunset, at the beginning of the month, the interval decreasing. At the end of the month he rises before the sun.

Venus sets three hours and a quarter after the sun on the 1st, the interval decreasing to an hour on the last day.

Jupiter may be observed at the beginning of the month throughout the night, till an hour before sunrise, the interval increasing. He sets on the 30th at an hour and a quarter after midnight.

Saturn rises just after midnight at the beginning of the month, and afterwards a little earlier each night. At the end of the month he rises at about 11 p.m.

OBSERVING NIGHTS.

APRIL, 1876.

Fair.	Bad.	Clear all night.
3	5	5

Bermerside Observatory, Halifax.

NEW RED STAR (?)

Translation of a letter from Mr. J. Birmingham in the *Astronomische Nachrichten.*

On the 13th of April I found a red star, the approximate position of which is R. A. 18h. 28m., Dec. + 36° 54′. It is not included in Schjellerup's Catalogue, and may prove to be new. Colour, intense red. Mag. 8·5.

Millbrook, Tuam, Ireland :
April 10, 1876.

J. BIRMINGHAM.
—(From *A. N.*, No. 2092.)

EPHEMERIS FOR PHYSICAL OBSERVATIONS OF JUPITER.

Greenwich. Midnight.	Longitude of ♃'s central merid.		Angle of position of ♃'s axis.	Annual parallax.	Latitude of earth	above ♃'s equator. sun
1876.	°	°	°	°	°	°
June 1	309·4		14·22	+3·07		
2	100·1	870·7	14·27	3·27		
3	250·8	·7	14·31	3·47		
—		·7				
4	41·5		14·35	+3·66	—3·15	—2·99
5	192·1	870·6	14·39	3·85		
6	342·8	·7	14·43	4·04		
7	133·5	·7	14·47	4·23		
8	284·2	·7	14·51	4·42		
9	79·9	·7	14·55	4·60	—3·13	—2·98
10	225·5	·6	14·59	4·78		
—		·7				
11	16·2		14·63	+4·96		
12	166·9	870·7	14·67	5·14		
13	317·5	·6	14·71	5·32		
14	108·2	·7	14·74	5·49	—3·11	—2·98
15	258·8	·6	14·77	5·66		
16	49·5	·7	14·80	5·83		
17	202·2	·7	14·84	6·00		
—		·6				
18	350·8		14·87	+6·16		
19	141·5	870·7	14·90	6·32	—3·09	—2·97
20	292·1	·6	14·93	6·48		
21	82·7	·6	14·96	6·64		
22	233·4	·7	14·99	6·79		
23	24·0	·6	15·02	6·94		
24	174·6	·6	15·05	7·05	—3·07	—2·97
—		·6				
25	325·2		15·07	+7·24		
26	115·8	870·6	15·09	7·39		
27	266·4	·6	15·12	7·53		
28	57·1	·7	15·14	7·67		
29	207·7	·6	15·16	7·81	—3·05	—2·96
30	358·3	·6	15·18	7·95		
July 1	148·9	·6	15·20	8·08		

A. M.

LUNAR OBJECTS SUITABLE FOR OBSERVATION IN JUNE, 1876.

By W. R. Birt, F.R.A.S., F.M.S.

In our list for April, 1876, we gave certain objects in or near "Fracastorius" as suitable for further investigation. The interest in lunar topography having somewhat revived of late, we now continue this list of objects.

VII. A small crater opened up on the high land forming the ascent on the south; it is situated close to the two ridges south-west of the south-east angle.

Note.—The craters II. and VII. are both opened out on the *same* high land that skirts "Fracastorius" on the east and south, passing the south-east angle, and after forming the ascent as far as midway of the south border, trends away to the south-west.

VIII. The west border, which is finely curved, terraced, and somewhat rough as though the interior had been undergoing degradation.

IX. A very minute hill near the centre of the floor.

Miss Ashley, of Bath, has favoured me with a sketch of "Fracastorius" as seen by her on May 12, 1876, from 14h. 16m. to 16h., with a 3·75-inch O.G. by Wray, power 185, in which she gives a somewhat large elevation *south of centre*. She describes it as having "gradually sloping sides." In connection with this elevation, Miss Ashley furnishes the following interesting information. After mentioning crater II. on the extremity of the east wall, "south of this crater there is a deep shadow *through* the wall like a pass, cutting through the ray from Tycho and running in a straight line of *sun-light* (query, a ridge) right across 'Fracastorius' to the south-west wall, where there is another deep shadow cutting through the wall. I could not see it just at the elevation. I think it passed to the south of it." Miss Ashley shows this rill or cleft, if such it be, interrupted by the south-east edge of the elevation, and bent towards it.

This feature on "Fracastorius" is perfectly new to me. The bending towards the elevation appears as if the elevation were the origin of the cleft, which extends outwards in nearly opposite directions south-west and north-east, at a very obtuse angle. Miss Ashley is a new observer, and it is somewhat remarkable that a feature so easily seen by her should have been overlooked so lately as 1870 and 1871 by such careful observers as Elger, Birmingham, and Neison.

DISCOVERY OF NEW MINOR PLANETS (162, 163). (162).

From *Astronomische Nachrichten* No. 2090.
By M. Prosper Henry, in Paris. (*Bulletin International* No. 113.)
1876. April 21. M. T. 13h. R. A. 14h. 9m. 58s.
Dec. S. 12° 18′
Daily motion in declination 3′ northerly.

(163.)

By M. Perrotin, at Toulouse. (*Bulletin International*, No. 118.)
April 26. R. A. 14h. 11m. 48s.
Dec. S. 6° 24′
Daily motion in dec. 7′ N. Magnitude, 12th.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To June, 1876.	To Dec., 1876.	To March, 1877.
Padbury, J.	Green, S.	Court, J.
To July, 1876.	Fleming, Rev. D.	Herschel, Prof. A. S.
Calver, J.		

TO CORRESPONDENTS.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to John C. Jackson, at Lower Clapton, London, E.

The Astronomical Register.

No. 163. JULY. 1876.

ROYAL ASTRONOMICAL SOCIETY.

Session 1876—77.

The last Meeting before the Long Vacation, June 9th, 1876.

William Huggins, Esq., D.C.L., LL.D., F.R.S., *President*, in the Chair.

Secretaries—Mr. Dunkin and Mr. Ranyard.

The minutes of the last Meeting were read and confirmed.

Mr. Ranyard announced that 76 presents had been received by the Society since their last meeting in May. Amongst them was a handsome large paper copy of Leovitius' *Ephemeridum Novum*, given by Lord Lindsay, and a box of letters which had been presented to the Society by the Rev. T. Sheepshanks, the nephew of the late Rev. R. Sheepshanks, who was for many years actively connected with the Society, and a diligent correspondent of many distinguished European astronomers.

A special vote of thanks was passed to Lord Lindsay and the Rev. T. Sheepshanks.

The following candidates for the fellowship of the Society were balloted for and duly elected:

Andrew Ainslie Common, Esq., of 37, Eaton-rise, Ealing, and

James Love, Esq., of 8, Talbot Lodge, Bickerton-road, Upper Holloway.

Dr. Mann was called upon to give a verbal account of a comparison which he had recently made between the performance of a 3½-inch achromatic, by Andrew Ross, and a 6½-inch silver-on-glass reflector, by With of Hereford.

The comparison had been made by placing the telescopes side by side and examining objects upon the moon from 4½ days of its age to 9½ days of its age. With low magnifying powers, up to 120 diameters, he had been unable to detect any detail with the reflector that he could not also see with the refractor. But

with higher powers, up to 230 diameters, details were seen with the reflector that were not visible with the refractor, and with the reflector the definition continued perfectly sharp, and beautifully crisp, with a power of 300 diameters, increased to 450 by the addition of a Barlow lens. On that ground the comparison was greatly in favour of the reflector. He was however of opinion that the shadows of lunar objects as seen with the refractor were much blacker than as seen with the reflector. His friend Mr. Stothert of Bath, who had made the comparison with him, was of opinion that the shadows as seen in the reflector were only of a neutral tint, while in the refractor they were perfectly black.

Mr. Wentworth Erck: I have had an opportunity of comparing two telescopes more nearly of the same aperture, viz., a 9-inch reflector, and a 7½-inch refractor, and I can certainly corroborate the statement as to the greater darkness of the field in the case of the refractor than in the case of the reflector. But with minute double stars the discs are decidedly smaller in the case of the reflector than with the refractor.

The Astronomer-Royal said: Perhaps on this subject I may state to the Society the result of an experiment of very short duration, which I had an opportunity of making a good many years ago, at the Paris Observatory. I had the good fortune to test one of Cauchoix's great reflectors, and I was quite amused with the precautions which it seemed necessary to take with these reflectors. There was a bag of air behind the vitreous part of the speculum, and from the bag of air there was a pipe communicating with the observer's mouth. The observer blew up the air to the proper degree of tension, in fact till the definition was perfect. When the bag was blown to the proper degree of tension the definition of the objects on the moon was infinitely superior to anything that I have ever seen with a refractor, in fact I have never seen any image at all comparable to that. I have no doubt whatever that geometrical definition can be better obtained with the reflector than with the refractor. With the reflector there is only one surface to be considered, while with the refractor there are four surfaces, and there is also the irrationality of the dispersion of the two glasses which can never be perfectly got rid of.

The President: At present we have before us only the case of silver on glass reflectors. I will ask Mr. Lassell whether he thinks that there is the same difference with respect to the darkness of the shadows with metal specula?

Mr. Lassell: I have had very small experience with silvered-glass mirrors, but those I have seen have the same defect (I may call it) as Dr. Mann has insisted upon with respect to the light-

ness of the shadows when they ought to be black. With metal specula I find the shadows blacker than with any achromatic I have ever seen, and free from any tinge of colour whatever. When the moon is in quadrature they are blacker than anything else I can conceive of. Nothing can surpass the beauty of the image from a perfectly parabolic speculum.

Professor Pritchard: We have at Oxford two instruments, one a reflector by Mr. De la Rue, and the other an achromatic, both of nearly equal aperture, one 12-in. and the other 13½. Our experience entirely coincides with what Mr. Lassell has said with regard to the blackness of the shadows. But the doubt I have of the superiority of the reflector to the refractor is this, that you can rarely use the reflector, whatever the cause may be—the currents of air or the alteration of heat, I know not what it is, but you can rarely use it to the best possible advantage. The instrument rarely comes up to its own idiosyncrasies, and we always revert back again to the refractor as the practical instrument, but supposing we could get the atmosphere, or currents of air, or whatever it is still, then undoubtedly for definition, we should go to the reflector. It is not very long ago that I was with Mr. With, who I presume has produced as fine mirrors as have ever been produced. Nothing can be more beautiful than the momentary definition that you get with his instruments, but it ceases after a few minutes and you have to wait. Mr. With, with all his experience, had continually to go to the tube, and blow with a fan in order to do something to get rid of something, and as soon as he had done that the definition became marvellous, but in a minute or two later the definition was gone again.

Mr. Lassell: With respect to the uncertainty of the working of specula, it depends very much I believe upon flexure. A speculum, whether large or small, at least down to 12 inches diameter, requires due support in all positions so as to enable it to be turned rapidly from one position to another, and it requires a few minutes to settle down to its best position. I know it is the case with my 2-ft. equatorial. If I have been observing for two or three hours east of the meridian and then turn the telescope rather suddenly, it may be five minutes before the speculum will come up to its proper action again. I attribute this to an elasticity which is sensitive to every change. But I believe that the double system of levers I have adopted completely eliminates all sensible strain, and it is to that I attribute the more uniform performance of my mirrors, in equal states of the atmosphere, than I have been led to suppose some other mirrors possess.

Lord Rosse: I wish to make one remark on the subject. It appears to me that what has been noticed by Dr. Mann may

admit of easy explanation. I refer, not to the definition, but to the lightness of the shadows. If there is the least degree of tarnish or oxide on the mirror, which frequently happens with the best mirrors that have not been polished very recently, there will always be diffused light over the whole field. In the case of the reflector much of this dispersed light will pass on through the eyepiece, and cause a faint illumination over the whole field, but in the case of the refractor, if there is any slight tarnish, or dispersion of light from the lenses, it will be thrown back towards the sky, and therefore will not cause a diffused light over the image. In fact, there is the same difference as if you were to take an object-glass and stick a number of pieces of white paper over it, you would diminish the amount of light, but if you were to take a reflector and stick a number of pieces of white paper upon it you would get a good deal of diffused light thrown up the tube, and that would cause a diffused illumination over the whole field, and would diminish the intensity of the shadows. It seems to me this may be a probable explanation in the case with the silver-on-glass mirrors. If they get the least improper usage they get rapidly tarnished, and the surface gets broken up, and it is difficult to get the same satisfactory blackness of the field as there is soon after the speculum leaves the maker's hands.

Dr. Mann explained that the reflector he used had just been re-silvered, and he felt certain it was perfectly brilliant.

Mr. Dunkin read a paper by Professor Newcomb, of Washington, entitled *On a hitherto unnoticed apparent inequality in the longitude of the moon.* The inequality had, it appeared, been brought to light in the course of an investigation having for its object the determination of the corrections to be applied to the lunar ephemeris derived from Hansen's *Tables de la Lune,* in order that that ephemeris might be used for the determination of such of the longitudes of the transit of Venus stations as depend on observations of occultations or moon culminations. The material used was the series of Greenwich and Washington observations of the moon, extending from 1862 to 1874, and the residual errors of the moon's place derived from Hansen's tables. These residuals were first corrected for the theoretical terms in which the tables seem to need emendation and for error of moon's semidiameter, and then for the mysterious error of epoch which has been so rapidly developed during the last 10 years.

When the several corrections were applied to residuals, Prof. Newcomb was surprised to find systematic outstanding errors, which could not be represented by corrections to the lunar elements. There could be no serious doubt of their reality, because the Greenwich and Washington observations agree in showing

them. At first, Prof. Newcomb was disposed to attribute them to inequalities in the surface of the moon, but a more careful examination showed that they were periodic and depended on the moon's longitude, being positive when the moon's longitude was between 180° and 360°, and negative in the first semi-circumference, but this was found to be subject to a sensible alteration, the point of maximum possible error moving forward to about 0° and that of negative error to 180° in the course of a few years' observations.

It was now evident that in the investigation of this inequality its period might during any one year be regarded as the same with that of the moon's mean anomaly, and that thus during this interval it would be identified with the corrections to the eccentricity and perigee. Owing, however, to the want of exact coincidence of period the apparent errors of eccentricity and perigee would be different from year to year, these elements would in fact appear to be affected with an inequality of longer period.

In order to make the investigation more complete, Prof. Newcomb also determined the corresponding corrections for the years 1847 to 1858, for which the residual errors of Hansen's tables are given in the Greenwich observations for 1859, the resulting corrections and the mode in which the new term is brought out are shown in the table given in the paper.

The period of N, the chief term of the new inequality, is $16\frac{2}{3}$ years, with a probable error of half a year, and a possible error of a year or more. The corresponding period of the inequality in longitude is 27·4304 days ±0·0040d. There is a large preponderance of probabilities against the real period, being either less than 27·42d. or greater than 27·44d.—no known term in the moon's longitude falls betweeen these limits. The moon's sidereal period is 27·32d., and her anomalistic period is 27·55d., so that the new term falls half way between the two.

The non-accordance of this period with any term heretofore sought for is the reason why this term has not before been noticed. A term if unknown would not be remarked, unless its magnitude was such as to visibly affect the individual comparisons of theoretical values with observations, and Hansen's tables as corrected are the first ones of which the residual errors are so small that a term of $1''\cdot5$ would be remarked in the comparison with observations.

Professor Adams (being called on by the President) said: I must apologise for saying anything on such a subject on the spur of the moment. From the account which Professor Newcomb has given, he seems to have satisfactorily established the existence of a new inequality, but I think it would require a very close

examination of the lunar theory to make out what is the cause of it. I am rather inclined on the first blush to suppose that it may be due in some way to the influence of the figure of the earth on the motion oft he moon; however, this is merely thrown out at the moment. The period is so curious, that it is very difficult to say to what the inequality is likely to be due.

The Astronomer-Royal said: Mr. President, I really have very little to say upon this matter. It seems to me that there is nothing which can be held to explain this inequality exactly. I do not by any means wish to deprecate the production of a reduced series of observations like this, for it is by processes of this kind that every good step has been made in the mathematical theory of the moon and planets. It was by observation in the first place that the eccentricity of the moon's orbit was determined. It was by observation that the great inequality in the motion of Jupiter and Saturn was determined before it was accounted for theoretically, and so it has been that every step in the lunar theory has been made. When I look upon these things I am inclined to think that, after all, theory is a very poor matter indeed. This paper of Professor Simon Newcomb's is one of those things which is likely to spur on us theorists to attempt to account for the observed fact, but at present I certainly do not see in what direction of the theory the fact points.

The President: I will ask the meeting to return its thanks to Professor Newcomb for the interesting and important paper he has contributed to us, and not only for the paper but for the remarks which it has elicited from our distinguished Fellows, Professor Adams and the Astronomer-Royal.

Lord Lindsay exhibited an altazimuth so constructed as to give an approximately equatorial motion. He said that the construction appeared to him so simple that he could hardly suppose that it had not been discovered before, though he had never seen any description of such a mounting. To the base of the altazimuth pillar is fixed an iron bar, through a hole in which a string or wire is attached to the object-glass end of the telescope; the only adjustments that are necessary are that the horizontal bar shall lie approximately north and south, and that the distance from the base of the altazimuth pillar to the hole in the bar—through which the string passes—shall be equal to the height of the pillar into the co-tangent of the latitude of the place of observation. The contrivance was so simple that he could hardly conceive that it could be new. Under the circumstances he thought it right to bring the instrument before the meeting. (Applause.)

The Astronomer-Royal said that the same principle was used by him in examining the object-glasses for the new transit circle

and equatorial in 1850, and since that it had been used for various other purposes. The principle was obvious, but there appeared to be some conditions introduced in Lord Lindsay's instrument which contribute to the efficiency of the movement more completely than in the form he had adopted in 1850.

Lord Lindsay said he was glad to have elicited the fact that the contrivance had been thought of before.

The President: I am sure you will anticipate me by giving thanks to Lord Lindsay for bringing forward this remarkably simple form of equatorial motion. It may be very useful for travellers.

Lord Lindsay then read a paper entitled *A note on a double image spectroscope.* The instrument was exhibited to the Society, and appeared to consist of an ordinary battery of dispersing prisms, mounted on a disc with a telescope and collimator, but between the battery of prisms and the collimator are two reversing prisms, the lower one of which receives one-half of the beam of parallel rays from the collimator, and reverses it in a plane parallel to the plane of the disc on which the battery of prisms is mounted. The other or upper inverting prism receives the other half of the beam from the collimator, and inverts it in a plane at right angles to this plane. On slightly turning the two inverting prisms round an axis parallel to the slit, the lower half of the beam, and consequently the lower half of the spectrum, is shifted, while the upper half of the spectrum remains stationary. The spectrum itself thus becomes a micrometer on which the shift of lines can be measured.

Prof. Pritchard said that he was himself about to bring before the Society a precisely similar instrument, but he was waiting until he had done some good work with it. He thought that the instrument, or something like it, had been contrived by Professor Zöllner.

Lord Lindsay said he did not wish to take any credit at all for the invention. The instrument was arranged after a conversation on the subject with Prof. Zöllner, and if he had not already explained that he intended to have done so.

The President said that he believed the idea of the two prisms to be due to Prof. Zöllner, but we were indebted to Lord Lindsay for carrying it out in so convenient a form. The instrument was, doubtless, capable of doing good work, but considering that the light was divided into two spectra, and also the loss of light at the surfaces of prisms, he did not think it so suitable for observing the motions of stars as the form of spectroscope employed at Greenwich.

The Astronomer-Royal asked leave to make a general observation. He had a great objection to hearing "suggestions" to the

Society of plans which had not been tried. He had had much experience of suggestions, and he knew how fallacious many of them were. No one should stake his credit on an instrument until it had been tried, and he asked the President of the Society to use his efforts to crush all suggestions.

Capt. Noble was called upon to read a paper *On some observations of Venus.* He said: I was very much struck by Mr. Brett's announcement at our last meeting that he had detected unmistakeable specular reflection from the body of Venus. Believing as I did that had the phenomenon been anything like so apparent as his very artistic drawing represented it to be, I must have seen it; I yet so far mistrusted my own experience as to admit the possibility that Mr. Brett's trained and artistic eye might have detected an appearance which had been previously overlooked by others less specially employed in observing form, light, and shade. Since the 12th of May, therefore, I have availed myself of every favourable opportunity for investigating the question of alleged specular reflection from Venus.

My first step was to examine the planet, which I did in daylight, twilight, and at dusk, with various powers, from 84 to 394, to see whether I could detect any indication of specular reflection by ordinary telescopic vision, but I could discover none whatever; the whole of the light in the neighbourhood of the illuminated limb being as homogeneous as it possibly could be. I then, using a power of 255, interposed a graduated wedge of dark glass, traversing it, with the utmost slowness, before the eye lens of my eye-piece until the planet was rendered invisible. Under these circumstances the first part to fade away was (as might, *a priori*, have been expected) that in the neighbourhood of the terminator, and the effect presented was of course that of the material reduction of the breadth of the crescent. Then the actual cusps vanished, and, finally, the central part of the illuminated periphery of Venus *went out altogether*, not the slightest sign, trace, or indication of specular reflection, or of one part being in the smallest degree brighter than another, being visible. With a very dark green eye-glass, too, of uniform tint, which extinguished the cusps, the light of the limb remained absolutely without difference of brightness of any description.

In addition to these observations, made and repeated on numerous occasions with a 4·2 inch Ross achromatic, I have examined the planet with the beautiful 6·25-inch Browning-With reflector, belonging to my friend Mr. H. J. Slack, employing his own wedge of dark glass for cutting off the light of the planet, and with precisely the same result. I can, then, only come to the conclusion that Venus does *not* exhibit anything whatever in

the shape of specular reflection, and that its apparition in Mr. Brett's case must have had its origin either in his instrument or in his eye.

It may not be uninteresting to add that while my experiments were in progress, I discovered that by waiting until the evening got dark enough, I, with a power of 154 (or in fact any other, but this is the one with which I made the discovery), could distinctly make a quasi-phosphorescent body of Venus out of the blue light resulting from the very slight over-correction of my object-glass. This "dark limb" was quite startling in its apparent objectivity, but as pointed out by Mr. Green in his oral address at our April meeting, it vanished completely on hiding the illuminated crescent.

Mr. Plummer was called upon to read a paper *On photometric experiments upon the light of Venus.* He said he believed that up to the present time no use had been made of the fact that the light of the planets Venus and Jupiter, when favourably situated, was sufficient to cast a well-defined shadow from an object. He said he had undertaken the following experiments with a two-fold object: first, in order to compare the light of Venus with that of the moon; and, secondly, in order to determine by observation the amount of light coming from Venus at its various phases.

The plan that he had adopted had been to compare the light of the planet with that of a standard sperm candle burning 120 grains of wax per hour, and to vary the distance of this until the shadow it casts upon a screen of white paper has an equal degree of intensity as that given by the planet. The arrangement was a modification of Rumford's photometer. The objects of which the shadows were observed were two equal cylindrical steel wires of $\frac{1}{14}$th of an inch diameter placed 9 feet in front of their respective screens, but the judgment was further assisted by noting also the shadows of the wooden lathes to which the wires were attached and whose thickness was about $\frac{1}{2}$ an inch.

The result of all the observations showed that the brightness of Venus at its greatest brilliancy was $\frac{1}{799 \cdot 5}$ of the mean brightness of the full moon. Mr. Plummer said he had been unable to find any previous comparison of the light of Venus with that of the full moon with which to compare this result, except that which may be inferred from Bond's observations given in the Memoirs of the American Academy, which gives the light of Jupiter at mean opposition as equal to $\frac{1}{6430}$ of that of the mean full moon, and the ratio of the light of Venus at greatest brilliancy to Jupiter as 4·864 to 1, which differs only very slightly from Seidel's comparison of these two planets, this will give a brilliancy for Venus about 65 per cent. greater than Bond has found.

A paper by Mr. Denning was read *On the visibility of Mercury; and of Venus in sunshine.* It appeared that during the late east elongation the planet Mercury has been seen with the naked eye by Mr. Denning on thirteen evenings. Between the 5th and the 28th of May there was no difficulty whatever in detecting it. It was only a question of weather. On the 7th, 8th, and 9th of the month Mercury looked brighter than a first magnitude star on the horizon. It was much more easily seen than Mars which was about 13° east of it, and compared favourably in point of brilliancy with α Aurigæ.

Venus, he said, has been quite conspicuous as a naked-eye object in sunshine during the last three months.

Mr. Brett was called upon to read a paper *On the proper motion of bright spots on Jupiter.* He said: There have recently appeared upon the disc of Jupiter two bright spots of such distinctness and isolation as peculiarly to adapt them for measurement. The series of four observations which he wished to lay before the Society extended over a period of 286 hours, 20 minutes mean time. The two spots occurred very near to the equator of Jupiter and were very well defined and free from entanglement with other markings. The distance between the two spots was about 42° of Jovian longitude, or about 33,000, miles and their diameter is about a fourteenth of the planet's diameter, or 6,310 miles. Taking the series of four observations together, the conclusion drawn by Mr. Brett is that the rotation period of these spots is less than the rotation period ordinarily given for the planet, and that the least proper motion of the spots it was necessary to assume, if the generally received rotation period of Jupiter was correct, was 165 miles per hour.

The President announced that owing to the advanced hour he should not invite discussion on the papers.

The meeting adjourned at a quarter past ten o'clock.

THE ROYAL OBSERVATORY.

Report of the Astronomer-Royal to the Board of Visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory, 1876, June 3. pp. 26.

The Royal Observatory, like those of Chaldæa, is especially occupied with the moon. We are reminded of this in the opening sentence. The report which I now present is intended to exhibit the condition of the Royal Observatory in 1876, May 8th; and to give its general history through twelve lunations, beginning with the full moon of 1875, May 20. After sundry particulars about the buildings and grounds, and the portable buildings and instruments used in the transit of Venus, we learn that whilst "of the large mass of MSS. now collected and arranged a considerable portion naturally relates to the internal history of the Observatory—material, disciplinarian, and scientific—a very large part also relates

to external science of many branches, and this may at some future time contribute in a most important degree to the authentic history of science during the middle of the present century." Numerous additions, by presents and purchase, have been made to the library. The transit circle, the sidereal standard clock, and the altazimuth, are all in good order; as also the great equatoreal, and the Sheepshanks and Shuckburgh equatoreals. Of the great equatoreal, we read that it is occasionally necessary to clean the large object-glass, and the removal of the compound glass from its cell; the separation of the two lenses, and the restoration of all to their places, are somewhat hazardous. Mr. Sims, at my request, has prepared a plan of mechanism by which all these movements will be effected by screw-motion; and I propose to bring it into action as early as possible." An ingenious form of bright-line-michrometer has been applied to the viewing telescope of the spectroscope by Mr. Hilger, and the accuracy with which lines in the faint spectra of stars can be measured is found to be greatly increased by this impediment. The reflex-zenith-tube is in a satisfactory state. Under the head of astronomical observations, the number of the fundamental or clock stars is 215, and whenever the sky is clear some of these are observed. The sun, the inferior planets, and the large exterior planets passing the meridian before 15h. are observed every week-day, the small planets passing before 13h. are observed on week-days in the first half of each lunation (the other half being effectually secured under the administration of M. Le Verrier). The moon is observed when visible at meridian passage on every day, without any exception. The Astronomer-Royal says, "The number of small planets has now become so great, and the interest of establishing the elements of all their orbits so small,—while at the same time the light of all those lately discovered is very faint, and the difficulty and doubt of observation greatly increased,—that I have begun to think seriously of limiting future observations to a small number of these objects. A German society proposes to observe in the next year, among the planets whose elements are known most accurately, a list of seventeen planets, including all which are sufficiently bright to be observed with few chances of mistake, and a sufficient number possessing the various characteristics of small and large inclinations and excentricities, and proximity to Mars and to Jupiter. This proposal appears to me to be probably worthy of attention at Greenwich." With the altazimuth, the moon and corresponding stars have been observed without intentional loss of a day on which she was visible. Amongst the observations made with the transit-circle, are 3485 transits, the separate limbs being counted as separate observations; 3374 circle-observations, each requiring a separate reading of the six, four, or ten microscope-micrometers. With the reflex-zenith-tube 39 pairs of observations of γ Draconis were made, the instrument being reversed between the observations, and 5 single observations. With the altazimuth, amongst other observations, 791 azimuths of the moon and stars, and 367 zenith-distances of the moon were taken. The following comparison shows the number of places of the moon observed with the transit-circle and altazimuth respectively:—With the transit-circle, 88, or 7.3 per lunation. With the altazimuth, 180, or 15.0 per lunation. Other observations made were occultations of stars by the moon, phenomena of Jupiter's satellites, the eclipse of the sun in September, and, by aid of the ephemeris of Saturn's satellites by Mr. Marth, measures of the distances and direction from the planet's body of five of the satellites were made on a number of days ranging from 13 to 20. An account of the progress in the reduction of observations follows; we see that to the observations with the meridional circle corrections are applied for defects of micrometer-screws,

and for reading of telescope micrometer, error of gradation, flexure, inclination of wire, and zenith-point; and that the correction for the error of the micrometer-screws during the year 1874, and of a small mistake in computation, has slightly altered the inferred value of the co-latitude from 38° 31′ 21″·35, as stated in the last report, to 38° 31″ 21′·52. [This is equivalent to a length of about 17 feet.] Preparations are begun for forming a catalogue of stars, based on all the observations commencing with 1868. The sun's chromosphere has been examined with the spectroscope on 30 days, and the prominences mapped out, whenever any were found. The number of prominences has been very small during the past year, but a very marked increase both in number and size is shown in the recent observations. Sixteen measures of the F line in the spectrum of the moon as compared with hydrogen give a displacement corresponding to a motion of less than two miles a second, which seems to show that the method of comparison now adopted is free from systematic error; and this is supported by the manner in which motions of approach and recession are distributed among the stars examined on each night of observation. The results recently obtained appear to be on the whole as consistent as can be expected in such delicate observations, and they support in a remarkable manner the conclusions of Dr. Huggins, with regard to the motions of those stars which he examined. Photographs of the sun have been taken with the photoheliograph on 182 days; and of these 350 have been selected for presentation. A large number of these show a complete absence of spots; though faculæ are commonly present. On one of the photographs, which was accidentally exposed while the drop-slit was being drawn up, there appears to be a faint image of a cloud-like prominence close to the sun's limb, though the exposure probably only amounted to a fraction of a second. A prominence of unusual brilliancy was seen with the spectroscope about the same time and in the same position with reference to the sun's limb. Photographs of some double stars and of the moon have been taken with the great equatoreal, and some trials have been made in photographing the solar spectrum and that of magnesium.

Magnetical and meteorological instruments and observations and their relations are next treated of. The number of days of magnetic disturbance in 1875 is only two. The principal results for 1875 are: mean westerly declination (approximate) 19° 21′. Mean horizontal force, 3·833. Mean dip 67° 41′ 5″ (by 9-inch needles), 67° 42.15″ (by 6-inch needles), 67° 43′ 34″ (by 3-inch needles). The examination of the readings of the deep-sunk thermometers from 1847 to 1873 has exhibited some laws which had been sufficiently established before this time, and some which were less known. Among the former were the successive retardations of seasons in successive descents, amounting to about four months at the depth of 25 Lat.; and the successive diminutions of the annual range of temperature. Among the latter is the character of the changes from year to year, which the great length of this series of observations brings well to light. It is found that from year to year the mean temperature of the surface for the year, varying by three or four degrees of Fahrenheit, follows in its changes the mean temperature of the atmosphere for the year; and that the changes of annual temperature are propagated downwards, retarded in phase, and diminishing in amount of change, in the same manner (though probably not following the same law) as the season changes. The inference from this is, that changes of temperature come entirely from the exterior, and in no discoverable degree from the interior; an inference which may be important in regard both to solar action and to geology. The Astronomer-Royal is engaged in tracing the possibility

of relation between the irregularities in the annual temperature and the irregularities in the annual produce of corn, but has not yet arrived at any perfectly satisfactory results.

The whole of the manuscript of the volume of "Greenwich Observations" for 1874, excepting that of the introduction, is in the printer's hands. For the year 1875, the whole of the manuscript of the transits, zenith distances, and altazimuth observations (with tabular calculations of the last) have been sent to the printer. A few sheets have been printed.

The results of observations of the small planets are communicated every quarter to M. Le Verrier. Observations of Jupiter's Satellites, &c., are transmitted occasionally to the Royal Astronomical Society. Daily meteorological results are given to M. Le Verrier, to the United States War Department, to the Registrar General, to the Meteorological Office, and to some daily newspapers; they are also exhibited to the public, on the walls of the Observatory Inclosure.

Of the 161 chronometers now in the chronometer room, 128 are box-chronometers, 25 pocket chronometers, and 8 deck-watches. Of these 47 are the property of the chronometer-makers, placed there on the annual competitive trial. Some of these are tried for some time in a temperature of nearly 100° Fahrenheit. The first six chronometers in the competitive trial of last year were, on the average, somewhat superior to those of 1874; the chronometer at the head of the list, in particular, being a very fine one. The Greenwich time-ball has been regularly dropped automatically on every day throughout the year, with the exception of seven days, when the violence of the wind made it imprudent to raise the ball, and of two days when there was accidental failure. The regulation of the Lombard Street Clock by galvanic current from Greenwich has worked satisfactorily during the past year, and the Westminster Clock has maintained its high character, its error having been below one second on 273 days during the year to which this report refers.

The personal establishment consists of Mr. Christie, chief and confidential assistant, and exercising full powers in the absence of the Astronomer Royal; Mr. Dunkin, superintendent of the supernumerary computers, especially of those engaged in the transit-reductions and in the advanced computations; Mr. Lynn, superintendent of the altazimuth, charged with the care of that instrument and with the reduction the observations, usually assisted by one supernumerary; Mr. Criswick superintends the care, &c., of chronometers and time-signals. Stationery and money accounts are also in his department. He is assisted by one supernumerary; Mr. Downing is principally engaged on the library and the manuscripts, which absorb much time; Mr. Thackeray is employed on the zenith-distance observations made with the meridian circle, and on the work of the chronograph.

The four gentlemen last mentioned are liable to be called on at any time to make observations with any of the astronomical instruments, and are, in fact, so employed to the utmost practicable demand on their strength. Six or seven young men, the terms of whose employment rest entirely on the discretion of the Astronomer Royal, are attached as supernumerary computers. They are easily induced to practice astronomical observations, and become trustworthy observers, capable of relieving the pressure on the regular assistants. In the magnetical and meteorological department Mr. Ellis is chief, with Mr. Nash subordinate. At present four supernumerary computers are employed. Mr. Maunder conducts all the work in the photographic and spectroscopic department. He is assisted by one supernumerary. In the course of his operations he

is practically the superintendent of the great equatoreal. Finally, three inferior servants (gate-porter, watchman, labourer), and a carpenter (who, though under no regular engagement, becomes, in fact, clerk of works) are a part of the permanent establishment of the Observatory. It is impossible in the present course of employments to dispense with the constant presence of workmen. The Astronomer Royal says, "It is my continued endeavour so to make myself acquainted with the current work of assistants, servants, and workmen, that I may possess a sufficient check of all, for effectively carrying out the scientific objects of the Observatory and for due attention to economy. This is secured in great measure by a system of reports, daily, weekly, or occasional." Under the head of extraneous work, we copy the following without abridgment: "I first advert to the operations connected with the Transit of Venus, carrying on the history from the last report. The observers all returned in the course of last summer, and I am happy to say without death or accident. I have to lament, however, the subsequent decease, on the West Africa Station, of Lieut. C. Cor.et, R.N., an officer who had my highest confidence. The chiefs of stations and other observers passed some time at Greenwich, engaged in the registering or reading of their observations; but all have now departed, with the exception of Captain Tupman, R.M.A., who is charged with the entire work of reduction, and with the superintendence of some junior computers within the Observatory, and several external to it; and of Lieut. Neate, R.N., who has nearly completed the Rodriguez reductions. The instruments also have all returned, with the exception of those from Kerguelen, which I have already mentioned as being lodged at Simons Town. At the moment of issuing this paper I learn that the Admiralty have taken efficient measures for the prompt return of these instruments."

In the astronomical part of the reductions there has been great labour and difficulty in the determination of local sidereal times; some books of observations required extensive transcription; some instrumental errors are still uncertain; the latter determinations have perplexed us so much that we are inclined to believe that, in spite of the great facilities of reduction given by the transit instrument, it would be better to rely on the altazimuth for time determinations. Generally, however, the local times are completed, except in Owhyhee, and the greater part of clock-comparisons and chronometer-comparisons are reduced. In the geographical longitudes little advance has been made; the errors of the moon's tabular place, as determined at four observations are under consideration. The Greenwich time in District A (Egypt) were, however, determined long ago (by the use of the long telegraph wire, as explained in the last report). Various printed forms have been prepared for the computations of tabular local parallaxes, &c., and a complete ephemeris of the geocentric places, parallaxes, and semidiameters, for every ten seconds of Greenwich sidereal time through the transit, has been printed and circulated.

In the photographic part I have confined my attention entirely to measures of distance between the centres of the sun and planet; and, using an instrument arranged specially for that purpose, have measured on the photographic images the distance of the four limbs in the line passing through the centre of the sun's disc, by reference to a scale of millimetres with microscopic micrometer. The first operation was to ascertain the corrections due to the small errors of the subdivisions of the millimetre scale. The next more complex step was (1) to photograph Mr. De la Rue's scale by planting the photoheliographs in succession at a place distant about 1700 feet; (2) to examine the errors of division of

Mr. De la Rue's scale; and thus (3) to measure the distortion of the photographic images. The measuring of the photographs of the Sun and Venus was, logically, the third operation. All these were done by Mr. Burton. The first part is entirely reduced, the second is partially reduced, the third is not corrected for the errors of scale and distortion. When finished, this operation will give measures in terms of the sun's apparent semidiameter. The photographs taken in India and Australia have been received, and have been measured with the same instrument; and I hope to make arrangements for including all in the same general system of reductions.

The point to which I next refer is the progress of the Numerical Lunar Theory. With a repetition of grant from the Treasury I have usually maintained four junior computers on this work. The progress, though considerable, has not been so great as I had hoped. The retard has arisen from two causes, both due to the excessive personal pressure upon me during the whole year. The first is the necessity of extending the calculations by one or two decimals. The necessity for this, in some degree, had been perceived from the first; but it was found imperative, on more careful consideration, to include a greater number of terms than I had anticipated. The second is that, at times, when I could not watch every step, my computers, unacquainted theoretically with the arithmetic of sines, had committed some grievous errors. Their numerical computations are, generally speaking, correct, so that the restoration to proper order will not be very difficult. The magnitude of these calculations, intended to secure exactitude to $10-7=0''\cdot02$, may be judged from the statement that in one of the terms, on the perturbed side of the equation, the number of arguments of inequalities is about 270, and that this is produced by repeated multiplications of one series of the same class by another series of the same class. In the perturbing side of the equations considerable progress has been made. I am not able yet to assert its immunity from error. The treatment of the symbolical corrections has not advanced.

The personal occupation of my time, produced by references on scientific matters extraneous to the Observatory, has been in the last year somewhat greater than usual. Under the head of "General Remarks" we read—"The year for which the history of the Observatory is given in the preceding Report has been one of unusual labour. The demands which this implied upon the efforts of the officers of the Observatory have been met in the best spirit. And I am bound to regard with gratitude, on the part of the Observatory and myself, the orderly and zealous conduct of every assistant connected with the Observatory. This labour, however, is not without fruits to counterbalance it. Faults of a totally unsuspected character have been detected in one instrument, and, I trust, have been perfectly corrected. After the warning which they have given, the probability of a recurrence is greatly diminished. In another, the methods for an important instrumental adjustment have been facilitated, and thereby rendered more certain of frequent application. In a new class of instruments, the experience in the numerous causes of error, and the practical forms of remedy, has given the chief assistant, who principally has superintended the use of those instruments, an accurate acquaintance with them possessed by few other observers. In the theory which I am myself promoting, though time has been lost, accuracy has been gained. Material matters, such as the care of manuscripts and library, and of the still lower subjects of buildings and grounds, have not been neglected. Friendly communication has been maintained with other observatories. Upon the whole, I trust that the present position of the Observatory will be regarded by the Visitors as satisfactory.

"Royal Observatory, Greenwich: G. B. AIRY."
1876, May 11.

We believe our readers will be obliged to us for the above extended abridgment of this very interesting Report, so fully expository of the actual state of the Royal Observatory. Its present position (as we cannot doubt the Visitors considered) *is indeed* satisfactory. It is more than that. We should like to think that every Government establishment was conducted with nearly the same amount of conscientiousness, of skilfulness, and of zeal. Everyone and everything appears to be in his and its place. Toil, monotonous and severe, is evidently endured from year to year with no abatement of cheerfulness, freshness of motive, and devotedness. We are amazed at the amount of ordinary work accomplished; and that withal eyes and brains able to undertake so much that is extraneous, and also delicate and difficult. The grateful appreciation of all, more especially of those who occupy themselves with astronomy, is due to the illustrious chief, whose spirit seems to animate the whole staff of his subordinates; and such appreciation, we question not, is felt by them to be no inconsiderable addition to whatever remuneration (always we fear inadequate) their services may receive. As regards the concluding part of the Report, Cæsar's wife, we remember, must be above suspicion. But the finest instruments, it may almost paradoxically be said, are suspected in the very proportion of their excellence. It is taken for granted that, to use a common expression, there is more than one "screw loose," and pains the most refined are taken to ascertain where the faults are. Happily, nevertheless, whether the looked for defects, or others not suspected, are discovered, it does not follow that the instrument, like Pompeia, is put away. On the contrary, its value, as in the present instance, may be enhanced. In respect of the latitude, as we have seen, the last determination has made the position of the instrument about 7 paces nearer to the equator than had been previously supposed. Could it speak, it might say with the Moor—

> "The very head and front of my offending
> Has this extent; no more."

But modern astronomy at Greenwich cannot overlook what might seem to some almost an inappreciable trifle. It is a consolation for the loss of the lamented Delaunay, and the incomplete state of his immense work on the Lunar Theory, to find that Sir George Airy's labours in the same field are steadily advancing. Those who have any insight into the nature of the stupendous calculations involved, are aware of the incessant difficulty of keeping out numerical errors. That the life and health of the Astronomer-Royal may enable him to continue his arduous labours and to complete this grand work, must be fervently desired by all.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

DOUBLE STAR 3 (κ) *CENTAURI.*

Sir,—In the *Register* last August there was a letter by J. A. Gore, India, calling attention to the possible variabilty of 3 (κ) Centauri, rated as high as mag. 2 by Harding. It is not so easy to estimate precisely the magnitude of an object so close to the horizon in England. On May 13, I had a very good view of it with a 4-in. telescope. The larger star

seemed a bright 5, the smaller 6½, the bluish tint of the latter very marked. I turned the instrument afterwards on 10 Hydræ as a sort of comparison. It is termed by Smyth 5½, 7½, but is decidedly inferior in brightness to 3 Centauri.

Upon-Helions Rectory, S. J. JOHNSON.
Crediton : May 16.

VENUS.

Sir,—Since my letter in the May number of the *Register*, I have availed myself of every opportunity of observing this planet, with the hope of being favoured with a view of its unillumined side, but all my efforts either with 4-inch o. g. or 9-inch reflectors have proved unavailing. I have, however, endeavoured to perceive the effect which some other observers consider to indicate the presence of the darker portion, and in this have been fairly successful.

I am told by one that the portion of the planet that lies beyond the direct rays of the sun appears of a coppery tinge. This I have seen on several occasions. By another that the unillumined side is a paler blue than the surrounding sky, and thus it has also appeared frequently. A third party considers that the darker portion becomes visible in consequence of being deeper in tint, and of this also I have had ocular demonstration, and agree with Capt. Noble that this effect is sometimes wonderfully definite. But all these several effects I believe to be simply so many optical illusions, as they vary with the instrument, the power, and the occasion, and in no instance will they bear the test of the small stop, or the dark band in the eye-piece, but to a great extent vanish as soon as the illumined portion is hidden.

My reasons for questioning the reality of this appearance are these: First, that many of the most keen observers, and especially those who have been the best delineators of planetary appearances have never seen this unillumined side, excepting when the planet is in immediate proximity to the sun, and then as a dark body against the light which is known to extend beyond the boundary of that luminary.

Second, because of the very considerable number of observers who believe that they see the unillumined portion, who do not find it a difficult effect to realize, and who speak of seeing it generally between quadrature and inferior opposition, and this without the employment of any great optical aid.

Third, that those who believe in the visibility of the darker portion vary considerably in their descriptions of the appearance by which it becomes visible.

These reasons, together with the singular facts that have come under my own notice, viz., that those who believed they saw the whole of the planet could not verify the appearance of the experiment with the dark band, and the still more remarkable instance of one, a practical observer, who could see it with a 4-inch achromatic, but failed to see it with a 9-in. reflector of far higher defining powers ; these reasons and facts, Mr. Editor, will, I am sure, be considered a sufficient excuse for my continued doubt of the visibility of the unillumined side of the planet Venus.

3, Circus Road, Yours very respectfully,
St. John's Wood. NATHL E. GREEN.

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452 *P. XX. CYGNI.*

Sir,—Admiral Smyth in the Bedford Catalogue (p. 493) gives measures of this as a double star, the larger component, a 7 magnitude, colour deep

yellow, and the comes an 11 magnitude, emerald hue. Position 297°·0, and distance 17″·0, for epoch 1832·87. He also mentions that Struve had marked it "Rej." (No. 2748), and that the latter speaks of a faint star, *s. f.* at a moderate distance, but no measures are given.

In September, 1862, Professor C. P. Smyth stayed for a few weeks at Elchies in Morayshire, Scotland, and examined this object amongst others, with Mr. Grant's 11-inch refractor. In adding two distant comites to the above he remarks (*Edinburgh Transactions*, vol. xxiii., p. 410) "on the happiness of re-observing an ancient stellar object with a larger instrument."

The following are his measures for the epoch 1862·73:

A	6 mag.	reddish orange	P. 300°·33	D. 19″·39	R. A. xxh. 57m. 4s.
B	10 „	greenish			
C	13 „	bluish	„ 86°·53	„ 98″·87	D. N. 38° 58″.
D	15½ „	bluish	„ 138°·54	„ 54″·76	

I turned a 4·3 in (Wray) equatoreal on this asterism, August, 1875, and added two fainter comites to Professor Smyth's star "C," with the following rough estimations: Magnitudes, 15,14; P. (from "C") 340° 140°; D. 20″, 35″ ±. I also found a 13½ magnitude comes in the s. p. quadrant from "A." Estimated position 230°, and distance 95″ ±.

On the 22nd May this year, when Cygnus came round to the east, I again examined the above group, and though nearly five hours from the meridian I picked up a very faint star preceding "A," estimated 15 magnitude (Smyth's scale) P. 270°; D. 20″ ±. There are also three or four other glimpse stars within 100″, but the strong twilight now here (54° 36′ N.) and the distance of the group from the meridian, render it difficult to give their positions with certainty. Should the new star (*p.* at 20″ ±) *not* be a variable it is singular that it should have been missed with the larger instruments.

Belfast: June 7.

Yours faithfully,
I. W. WARD.

SATELLITES OF SATURN.

Approximate Greenwich sidereal times of those conjunctions of the satellites with the centre of the planet and with the ends of the ring, and also of their greatest elongations, which occur between 16h. and 4h. Greenwich sidereal time.

f. conj. with following edge of ring.
p. „ „ preceding „ „
sup. superior. inf. inferior conj. with centre of ball.
n. north. s. south of ring. e. and w. at the greatest elongation, east and west.

1876.		Gr. Sid. Time. h		
July	1	17·5	Encel.	nf.
		19·4	Dione.	w.
		10·6	Rhea.	inf. s.
		19·7	Tethys.	w.
		22·5	Encel.	e.
		0·1	Rhea.	sp.
		1·9	Mimas.	w.
		3·6	Encel.	sf.
		3·6	Tethys.	np.
	2	18·4	Tethys.	e.
		20·0	Encel.	np.
		22·7	Rhea.	w.
		0·5	Mimas.	w.
		2·3	Tethys.	sf.
		2·4	Encel.	nf.
	3	16·9	Dione.	sf.
		17·1	Tethys.	w.
		18·9	Encel.	sp.
		21·5	Rhea.	np.
		23·2	Mimas.	w.
		0·0	Encel.	w.
		0·7	Dione.	sp.
		1·0	Tethys	np.
		1·9	Rhea.	sup. n.

1876.	Gr. Sid. h.	Time.	
4	16·4	Encel.	e.
	21·5	Encel.	sf.
	21.9	Mimas.	w.
	23·7	Tethys.	sf.
	1·9	Dione.	np.
	3·9	Encel.	sp.
5	20·4	Encel.	nf.
	20·6	Mimas.	w.
	22·2	Dione.	e.
	22·4	Tethys.	np.
	1·4	Encel.	e.
	3·7	Rhea.	sf.
6	17·9	Encel.	w.
	18·5	Dione.	sp.
	19·2	Mimas.	w.
	21·1	Tethys.	sf.
	22·9	Encel.	np.
	4·1	Tethys.	sp.
7	17.9	Mimas.	w.
	19·7	Dione.	np.
	19·8	Tethys.	np.
	21·8	Encel.	sp.
	2·8	Tethys.	nf.
	2·9	Encel.	w.
	3·4	Dione.	nf.
8	16·0	Dione.	e.
	16·6	Mimas.	w.
	18·6	Tethys.	sf.
	19·1	Rhea.	nf.
	19·4	Encel.	e.
	0·4	Encel.	sf.
	1·5	Tethys.	sp.
	3·9	Mimas.	e.
9	16·9	Encel.	np.
	17·3	Tethys.	np.
	17·7	Rhea.	e.
	23·3	Encel.	nf.
	0·2	Tethys.	nf.
	1·0	Dione.	w.
	2·6	Mimas.	e.
10	16·0	Tethys.	sf.
	16·4	Rhea.	sf.
	20·8	Encel.	w.
	20·9	Rhea.	inf. s.
	21·3	Dione.	nf.
	22·9	Tethys.	sp.
	1·3	Mimas.	e.
	1·4	Rhea.	sp.
	1·9	Encel.	np.
11	18·3	Encel.	sf.
	21·	Moon near.	
	21·6	Tethys.	nf.
	22·5	Dione.	sf.
	0·0	Mimas.	e.
	0·1	Rhea.	w.

1876.	Gr. Sid. h.	Time.	
	0·7	Encel.	sp.
12	17·2	Encel.	nf.
	18·8	Dione.	w.
	20·3	Tethys.	sp.
	22·3	Encel.	e.
	22·6	Mimas.	e.
	22·7	Rhea.	np.
	3·2	Rhea.	sup. w.
	3·3	Encel.	sp.
13	19·0	Tethys.	nf.
	19·8	Encel.	np.
	21·3	Mimas.	e.
	2·2	Encel.	nf.
	2·9	Tethys.	e.
	3·7	Dione.	e.
14	16·3	Dione.	sf.
	17·7	Tethys.	sp.
	18·7	Encel.	sp.
	20·0	Mimas.	e.
	23·7	Encel.	w.
	0·0	Dione.	sp.
	1·6	Tethys.	w.
15	16·2	Encel.	e.
	16·5	Tethys.	nf.
	18·7	Mimas.	e.
	21·2	Encel.	sf.
	0·4	Tethys.	e.
	1·2	Dione.	np.
	3·6	Encel.	sp.
16	17·3	Mimas.	e.
	20·1	Encel.	nf.
	20·5	Titan.	inf. 21″ s.
	21·6	Dione.	e.
	23·1	Tethys.	w.
	1·2	Encel.	e.
17	15·9	Rhea.	sup. n.
	16·0	Mimas.	e.
	17·6	Encel.	w.
	17·9	Dione.	sp.
	20·4	Rhea.	nf.
	21·8	Tethys.	e.
	22·7	Encel.	np.
	3·4	Mimas.	w.
18	19·1	Rhea.	e.
	19·1	Dione.	np.
	20·5	Tethys.	w.
	21·6	Encel.	sp.
	2·0	Mimas.	w.
	2·6	Encel.	w.
	2·8	Dione.	nf.
19	17·7	Rhea.	sf.
	19·1	Encel.	e.
	19·2	Tethys.	e.
	22·2	Rhea.	inf. s.
	0·1	Encel.	sf.

1876.	Gr. Sid. Time.		
	h.		
	0·7	Mimas.	w.
	2·7	Rhea.	sp.
	3·1	Tethys.	sf.
	4·0	Dione.	sf.
20	16·6	Encel.	np.
	17·9	Tethys.	w.
	23·0	Encel.	nf.
	23·4	Mimas.	w.
	0·3	Dione.	w.
	1·4	Rhea.	w.
	1·8	Tethys.	np.
	4·1	Encel.	e.
21	16·6	Tethys.	e.
	20·6	Encel.	w.
	20·6	Dione.	nf.
	22·1	Mimas.	w.
	0·0	Rhea.	np.
	0·5	Tethys.	sf.
	1·6	Encel.	np.
22	18·1	Encel.	sf.
	20·7	Mimas.	w.
	21·8	Dione.	sf.
	23·2	Tethys.	np.
	0·5	Encel.	sp.
23	17·0	Encel.	nf.
	18·2	Dione.	w.
	19·4	Mimas.	w.
	21·9	Tethys.	sf.
	22·0	Encel.	e.
	3·1	Encel.	sf.
24	18·1	Mimas.	w.
	19·5	Encel.	np.
	20·6	Tethys.	np.
	1·9	Encel.	nf.
	3.1	Dione.	e.
	3·5	Tethys.	nf.
25	16·8	Mimas.	w.
	18·4	Encel.	sp.
	19·3	Tethys.	sf.
	23·4	Dione.	sp.
	23·5	Encel.	w.
	2·3	Tethys.	sp.
26	15·9	Encel.	e.
	17·2	Rhea.	sup. w.
	18·0	Tethys.	np.
	21·0	Encel.	sf.
	21·7	Rhea.	nf.

1876.	Gr. Sid. Time.		
	h.		
	0·6	Dione.	np.
	1·0	Tethys.	nf.
	2·8	Mimas.	e.
	3·4	Encel.	sp.
27	16·7	Tethys.	sf.
	19·9	Encel.	nf.
	20·4	Rhea.	e.
	20·9	Dione.	e.
	23·7	Tethys.	sp.
	0·9	Encel.	e.
	1·5	Mimas.	e.
28	17·2	Dione.	sp.
	17·4	Encel.	w.
	19·0	Rhea.	sf.
	22·4	Tethys.	nf.
	22·4	Encel.	np.
	23·5	Rhea.	inf. s.
	0·1	Mimas.	e.
	4·0	Rhea.	sp.
29	18·4	Dione.	np.
	21·1	Tethys.	sp.
	21·3	Encel.	sp.
	22·8	Mimas.	e.
	2·2	Dione.	nf.
	2·4	Encel.	w.
	2·7	Rhea.	w.
30	18·8	Encel.	e.
	19·8	Tethys.	nf.
	21·5	Mimas.	e.
	23·9	Encel.	sf.
	1·3	Rhea.	np.
	3·4	Dione.	sf.
	3·7	Tethys.	e.
31	16·4	Encel.	np.
	18·5	Tethys.	sp.
	20·2	Mimas.	e.
	22·8	Encel.	nf.
	23·7	Dione.	w.
	2·4	Tethys.	w.
	3·8	Encel.	e.
Aug. 1	17·2	Tethys.	nf.
	18·8	Mimas.	w.
	19·4	Titan.	inf. 22″9 s.
	20·0	Dione.	nf.
	20·3	Encel.	w.
	1·1	Tethys.	e.
	1·3	Encel.	np.

Difference of right ascension (α—A) and declination (δ—D) of Titan and Iapetus and of the centre of Saturn. For oh. Gr. Sider. Time.

	Titan.		Iapetus.	
	α—A.	δ—D.	α—A.	δ—D.
	s.	″	s.	″
July 1	—5·32	—10·8	+14·26	—11.3
2	9·15	—0·7	16·94	7·5
3	11·53	+9·2	19·50	—3·7

4	12·02	18·1	21·94	+0·1
5	10·51	23·9	24·24	3·9
6	7·25	25·7	26·38	7·7
7	—2·78	22·9	28·35	11·4
8	+2·16	17·2	30·14	15·0
9	6·77	+8·4	31·72	18·5
10	10·38	—1·8	33·10	21·9
11	12·49	11·8	34·25	25·1
12	12·82	20·1	35·19	28·2
13	11·35	25·7	35·90	31·0
14	8·26	27·8	36·37	33·6
15	+4·00	25·9	36·59	36·0
16	—0·86	—20·2	+36·58	38·1
17	—5·60	—11·5	+36·33	+39·9
18	9·48	—1·0	35·85	41·4
19	11·84	+9·8	35·14	42·7
20	12·27	19·0	34·21	43·7
21	10·65	25·2	33·05	44·3
22	7·25	27·2	31.68	44·7
23	—2·64	24·8	30·11	44·8
24	+2·41	18·8	28·36	44·6
25	7·09	+9·1	26·42	44·0
26	10·72	—1·7	24·32	43·2
27	12·80	12·3	22·06	42·1
28	13·04	21·2	19·64	40·8
29	11·45	27·2	17·11	39·2
30	8·24	29·5	14·48	37·5
31	+3·84	27·6	11·75	35·3
Aug. 1	—1·12	—21·7	+8·94	+33·0

To find the places of the five inner satellites, the values in the followiug table must be interpolated for the time required (360° and its mnltiples being subtracted.)

oh. Greenwich Sidereal Time.

1876.	Mimas.		Encel.		Tethys.		Dione.		Rhea.	
	l.	diff.	l.	diff.	l.	diff.	l.	diff.	l.	diff.
June	°	°	°	°	°	°	°	°	°	°
29	198·4	1905·0	302·2	1310 3	283·7	951·0	32·7	656·0	35·7	397·5
July										
4	303·4	5 0.	172·5	·3	154·7	·1	328·7	·1	73·2	·5
9	48·4	5·1	42·8	·3	25·8	·1	264·8	·1	110·7	·6
14	153·5	5·0	273·1	.3	256·9	·2	200·9	·1	148·3	·6
19	258·5	5·1	143·4	·4	128·1	·2	137·0	·1	185·9	397·6
24	3·6	5·1	13·8	·4	359·3	·1	73·1	656·2	223·5	
29	108·7	1905·1	244·2	1310·4	230·4	951·2	9·3			
Aug.										
3	213·8		114·6		101·6					
	a''	b''	a''	b''	a''	b''	a''	b''	a''	b''
July	"	"	"	"	"	"	"	"	"	"
4	27·0	3·0	35·1	3·8	44·4	4·8	56·9	6·2	79·5	8·7
14	28·4	3·2	35·6	4 0	45·1	5 1	57·7	6·5	80·6	9·0
24	28·7	3·3	36·0	4·2	45·6	5·3	58·4	6·8	81·6	9·5

When the co-ordinates x″, y″ of the satellites, reckoned parallel to the axes of the ring, are found by $x'' = a'' \sin l$, and $y'' = b'' \cos l$, and if angles of position p and distances s″ are wanted by

$$s'' \sin (p - 5{\cdot}9) = a'' \sin l$$
$$s'' \cos (p - 5{\cdot}9) = b'' \cos l.$$

A. MARTH.

ASTRONOMICAL OCCURRENCES FOR JULY, 1876.

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. α Herculis.
Sat	1	21	Conjunction of Moon and Jupiter 5° 31′ N. Sidereal Time at Mean Noon, 6h. 39m. 31·35s.	1st Tr. I. 1st Sh. I. 1st Tr. E.	10 50 11 46 13 2	10 27·8
Sun	2	10 7 10 43 11 40	Occultation of 4 Scorpii (6½) Reappearance of ditto Occultation of π Scorpii (3)	1st Ec. R.	11 15 17	10 23·8
Mon	3		Sun's Meridian Passage 3m. 59·42s. after Mean Noon	1st. Sh. E. 3rd Tr. I. 3rd Tr. E.	8 28 9 13 11 10	10 19·9
Tues	4	18 37	○ Full Moon			10 16·0
Wed	5	12	Conjunction of Mars and Venus, 4° 28′ S.			10 12·1
Thur	6	10 15	Near approach of B.A.C. 6666 (6)			10 8·1
Fri	7			2nd Tr. I. 1st Sh. I. 1st Tr. E.	9 56 12 1 12 30	10 4·2
Sat	8	10 19	Occultation reappearance of 27 Capricorni (6)	1st Tr. I.	12 39	10 0·3
Sun	9			1st Ec. R. 1st Oc. D.	8 57 24 9 56	9 56·3
Mon	10	13 25 14	Near approach of Saturn Conjunction of Moon and Saturn 0° 34′ S.	1st Tr. E. 1st Sh. E.	9 19 10 23	9 52·4
Tues	11	11 28 12 35	Occultation of B.A.C. 8184 (5½) Reappearance of ditto			9 48·5
Wed	12	9 58	☾ Moon's Last Quarter			9 44·5
Thur	13	13 5 13 59 22	Occultation of *t* Piscium (4) Reappearance of ditto Inferior conjunction of Venus and Sun			9 40·6
Fri	14		Saturn's Ring: Major axis=41″·58 Minor axis=4″·65	3rd Ec. R.	9 12 8	9 36·7
Sat	15		Illuminated portion of disc of Venus=0·001 Illuminated portion of disc of Mars=0·998			9 32·7

DATE.		Principal Occurrences. h. m.		Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. α Herculis.
Sun	16	11 49	Occultation reappearance 9 Tauri (6)	1st Ec. R.	11 34 46	9 28·8
		14 36	Near approach of 17 Tauri (4)	1st Oc. D.	11 46	
		14 31	Occultation of 23 Tauri (5)			
		15 26	Reappearance of ditto			
		15 3	Occultation of η Tauri (3)			
		15 57	Reappearance of ditto			
Mon	17		Sidereal Time at Mean Noon, 7h. 42m. 36·29s.	1st Tr. I.	8 57	9 24·9
				1st Sh. I.	10 6	
				1st Tr. E.	11 9	
Tues	18	13 19	Occultation of 136 Tauri (5)	1st Ec. R.	9 33 16	9 20·9
		14 4	Reappearance of ditto			
			Sun's Meridian Passage 5m. 57·39s. after Mean Noon			
Wed	19	0 25	● New Moon			9 17·0
		12	Conjunction of Moon and Mercury 5° 14′ S.			
		23	Conjunctionof Moon and Venus 10° 43′ S.			
Thur	20					9 13·1
Fri	21	4	Conjunction of Moon and Mars 2° 35′ S.	3rd Oc. R.	8 31	9 9·1
				3rd Ec. D.	11 23 21	
Sat	22	14	Conjunction of Venus and Mercury, 6° 36′ N.			9 5·2
Sun	23			2nd Oc. D.	9 11	9 1·3
Mon	24			1st Tr. I.	10 48	8 57·3
Tues	25			1st Oc. D.	8 5	8 53·4
				2nd Sh. E.	9 4	
				1st Ec. R.	11 27 59	
Wed	26	6 17	☽ Moon's First Quarter	1st Sh. E.	8 42	8 49·5
Thur	27	14	Quadrature of Neptune with Sun			8 45·5
Fri	28			3rd Oc. D.	10 13	8 41·6
Sat	29					8 37·7
Sun	30					8 33·7
Mon	31					8 29·8
AUG.						
Tues	1			2nd Sh. I.	9 3	8 25·9
				2nd Tr. E.	9 5	
				1st Oc. D.	9 57	

THE PLANETS FOR JULY.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	5 25 53	N.19 11½	9″·4	22 42·6
	9th	5 49 58	N.20 53½	7″·6	23 35·2
	17th	6 36 8	N.22 27½	6″·2	22 49·7
	25th	7 40 11	N.22 18	5″·4	23 22·2
Venus ...	1st	8 2 27	N.18 13	52″·8	1 22·7
	9th	7 45 30	N.17 6	56″·6	0 34·4
	17th	7 21 52	N.16 17	56″·8	23 35·4
	25th	7 5 12	N.16 0	53″·4	22 47·3
Jupiter ...	1st	15 21 44	S. 17 31	39″·8	8 40·8
	9th	15 20 23	S. 17 28	39″·2	8 8·0
	17th	15 19 49	S. 17 28	38″·4	7 36·0
	25th	15 20 1	S. 17 30½	37″·4	7 4·7
Saturn ...	1st	22 40 57	S. 10 11½	16″·4	15 58·8
	9th	22 40 7	S. 10 18	16″·6	15 26·5
	17th	22 38 56	S. 10 27	16″·6	14 53·9
	25th	22 37 26	S. 10 35	16″·8	14 21·0

Mercury rises about an hour before the sun at the beginning of the month, the interval slightly increasing till the 15th, from which day the interval decreases.

Venus sets nearly with the sun. Towards the end of the month she rises an hour and a quarter before the sun.

Jupiter may be observed at the beginning of the month till a little after midnight, and till an hour before midnight at the end of it.

Saturn rises about an hour and a half after sunset, the interval decreasing.

LUNAR OBJECTS SUITABLE FOR OBSERVATION IN JULY, 1876.

By W. R. Birt, F.R.A.S., F.M.S.

The advent of Mr. Neison's book on the moon marks, without doubt, an era in Selenography, and we hope it will not be accompanied by a similar result to that which followed the appearance of the *Mappa Selenographica* and *Der Mond* of Mädler, viz., that with the prevailing opinion "that the moon was to all intents an airless, waterless, lifeless, and unchangeable desert" * * * the attention of astronomers was directed to other fields, and Selenography, resting on its laurels, made no further progress for many years. Mr. Neison's work so distinctly meets the present requirements of Selenography that combined with the progressive character of selenographical research during the past twelve years, our ardent expectation is that it will rather incite to closer and more systematic observation than induce the notion that it is only in a few obscure and unobserved regions that any results are likely to be obtained.

The formation *Fracastorius* having of late attracted increased attention, it may be well to notice a few of the newer features mentioned by Mr. Neison; the more prominent, or rather important, of which is a curved

rill (cleft) ϕ of Neison; the eastern part of this rill appears to coincide with the north-east parts of Miss Ashley's ridge (see list for June), the south-west part of which is not given by Neison. The southern portion of this rill was discovered by Neison in 1873, the eastern part by Gaudibert in 1874. A short rill ζ running north-west and south-east nearly join the north-east end of ϕ, and apparently forming a continuation of it, was also discovered by Gaudibert. Neison gives another rill, ψ, close under the west wall, which he describes as very delicate, it was discovered in 1875. Of craterlets within the enclosure of *Fracastorius*, Neison mentions twenty, ten north of and included within the space bounded on the south by the rills ψ ϕ and ξ, and ten on the south of these rills. The continuation of Miss Ashley's ridge to the south-west is not given by Neison, and also some other features are absent, drawings of which are in our possession, we propose to draw attention to them next month.

Mr. Neison has drawn a dotted line, somewhat resembling Mr. Simms's two wide bays, connecting the extremities of the rills ψ and ξ; the position of this line is not accordant with the line shewing the bays on Mr. Simms's drawing (*English Mechanic*, No. 571, p. 634). Those of our readers who possess the two drawings by Simms and Neison will do well to compare them with the moon at the telescope during several lunations.

EPHEMERIS FOR PHYSICAL OBSERVATIONS OF JUPITER.

Greenwich. Midnight. 1876.		Longitude of ♃'s central merid.	diff.	Angle of position of ♃'s axis.	Annual parallax.	Latitude of earth above ♃'s equator.	Latitude of sun above ♃'s equator.
		°	°	°	°	°	°
July	1	3·8		15·20	8·05		
	—		870.6				
	2	154·4	·5	15·22	8·18		
	3	304·9	·6	·23	8·30		
	4	95·5	·6	·24	8·43	—3·03	—2·95
	5	246·1	·6	·26	8·55		
	6	36·7	·6	·27	8·67		
	7	187·3	·5	·28	8·79		
	8	337·8	·6	·29	8·90		
	—						
	9	128·4	·6	15·30	9·01	—3·00	—2·95
	10	279·0	·5	·31	9·11		
	11	69·5	·6	·32	9·21		
	12	220·1	·5	·33	9·31		
	13	10·6	·6	·34	9·41		
	14	161·2	·5	·35	9·50	—2·98	—2·94
	15	311·7	·6	·35	9·59		
	—						
	16	102·3	·5	15·35	9·68		
	17	252·8	·6	·36	9·76		
	18	43·4	·5	·36	9·84		
	19	193·9	·5	·36	9·92	—2·96	—2·94
	20	344·4	·5	·36	9·99		
	21	134·9	·5	·36	10·06		
	22	285·4	·6	·36	10·13		
	—						

23	76·0	·5	15·35	10·20		
24	226·5	·5	·35	10·26	—2·94	—2·93
25	17·0	·5	·35	10·32		
26	167·5	·5	·34	10·38		
27	318·0	·5	·33	10·44		
28	108·5	·5	·32	10·49		
29	259·0	·5	·31	10·54	—2·92	—2·92
—						
30	49·5	·5	15·30	10·58		
31	200·0	870·4	·28	10·63		
Aug. 1	350·4		·27	10·67		

A. M.

Books received.—"Beobachtungen der Sonnenflecken." II. Von Prof. Dr. G. Spörer. Leipzig. W. Engelman. 1876.—Report of the Astronomer-Royal to the Board of Visitors of the Royal Observatory, Greewich. 1876.—Dr. Dionysius Lardner's "Handbook of Astronomy," revised by Edw. Dunkin. London: Crosby, Lockwood & Co.—Symon's "British Rainfall for 1875." London: Edward Stanford. 1876.—Dr. W. Dorberck "On ω Leonis considered as a revolving double star." Dublin: Royal Irish Academy. 1876.—"The Moon." By E. Neison. London: Longmans & Co. 1876. "The Watchmaker and Jeweller." A. Victor. London, 1876.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

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The Astronomical Register.

No. 164. AUGUST. 1876.

THERMOGRAPHY OF THE SUN.

In the 10th volume of the *American Journal of Science*, page 50, the discovery of a method is announced, by the aid of which, it is asserted, the "isothermals of the solar disc" may be thermographically represented. In consideration of the importance of the matter, year and day of the invention are precisely given by the author. It is stated: "On the 5th of June, 1875, I devised a method of obtaining the isothermals on the solar disc. As this process may create an entirely new branch of solar physics, I deem it proper that I should give a short account of it, in order to establish my claim as its discoverer."

Though I am not as fully convinced as Mr. Alfred Mayer that by employing thermographic methods an entirely new branch has been created for solar physics, I have yet grounds for feeling an interest in researches of that kind, since as early as the spring of 1873, the idea occurred to me to make use of the property of some chemical combinations to undergo changes through heat for the purpose of visibly showing in a simple way the difference in the radiation of heat between the solar spots and their surroundings.

In No. 1949 of the *Astronomische Nachrichten*, I have published the result of my researches with regard to the subject, under the heading of "Ein thermographischer Versuch an der Sonne," and a short notice likewise appeared in print in the *Monthly Notices*.

The chemical combination which I employed in order to produce thermographic images of the solar disc was chlorocobalt. This salt, as is well known, secretes water when exposed to heat, and thereby changes its red colour to blue. The images of the sun produced on a paper saturated with a solution of this salt distinctly showed the decrease of the radiation of heat towards the edge, by the coloration of blue becoming paler; other

shades of tint, from which a conclusion of the existence of eccentric or otherwise formed curves of equal intensity of radiation might have been drawn, were not observable. Just as in photographs also in the thermographs, the effect decreased in gradation from the centre towards the edge.

Meusel's double salts,* which have later on been employed by Mr. Mayer, gave me by far more unfavourable results, on which account it was considered unnecessary to make particular mention of them in No. 1949 of the *Astronomische Nachrichten.* The endeavour to produce a regularly defined image of the sun proved unsuccessful. These preparations are altogether not applicable to the rendering of more delicate gradations in the effects of heat, as they take place between the middle and the edge of the sun, to which must be added that the occurring change of colour after the cessation of the effect of heat, disappears again very quickly, consequently a quiet observation of the thermography is becoming an impossibility.

A great obstacle to all thermographic methods consists in heat possessing the quality of being propagated not only by radiation but also by conduct, and it must consequently appear difficult to succeed in producing by means of rays of heat images as sharply defined as they can be produced by means of rays of light. We know of no body which is absolutely not a conductor of heat, and though paper—which is generally used as a base for matters subject like the above mentioned to being affected by heat—belongs to the bad conductors, it yet conducts sufficiently to interfere with the progress of the action to such a degree as essentially to disturb the exactness of the images to be produced. Having regard to this circumstance, it is evident that the results obtained by Mr. Mayer must at the outset be received with great caution. I feel inclined to set down the discoveries which have been made as actually only apparent, and accordingly to interpret literally the sentence by which the conclusions 1—5 are introduced, and which run thus: "As far as the few observations have any weight, the following *appear* to be the discoveries already made of this new method."

The motions that have been observed, and the variable magnitude of the "area of maximum temperature" are more than anything calling forth the special distrust of the initiated, and for this reason, because unless sufficient caution be used it usually happens that the hot air rising from the sensible surface generates quite irregular excrescences on the thermographic images of the sun which are to be produced.

* Meusel's iodide of copper and mercury and silver and mercury.

With regard to the researches in question, the words "temperature and isothermals" must appear altogether unfortunately chosen, for isothermals of the "solar *disc*," as it for instance may be projected by the aid of a telescope on a white screen, can certainly not be spoken of, regard being had to the meaning of the word, and it is at all events evident that a determination of the curves of equal temperature on the sun himself, is not what has been in the author's mind.

It may indeed be the case that not all parts of the surface of the sun have the same temperature; we may even with some probability conjecture that, especially during the times of the more frequent appearance of the sun-spots, the equatorial regions of the sun are hotter than the poles, and for this reason, because at those times the emission of the inner hotter matter attains its maximum; but the examinations of the sun's disc made with the thermopillar show that it is difficult to prove this even by the most sensitive aids. It will never be possible to obtain this proof by the aid of the thermographic processes, which have hitherto been made use of, the effect moreover would be a quite different one from that observed by Mr. Mayer.

The photographs show a heightened intensity of light of the equatorial zone, which particularly makes it observable in the faculæ, but that even this difference does not prove very great for our perception, is best shown by the fact of its becoming visible only by means of the effect of the sun's atmosphere. In the middle of the disc these faculæ are no longer observable. Something similar ought to show itself also on the thermographs if the method employed afforded sufficient security for the attainment of an exact thermographic image, which, however, as is evident from what has been said above, is not the case.

Since, then, the peculiarly formed "isothermals" of Mr. Mayer could only be referred to the effect of the atmosphere of the sun, and since the notion that it had been intended to prove a difference in the real temperature of different parts of the surface of the sun cannot possibly be entertained on account of the insensibility of the method employed, one would have to assume local clearings up, or condensations of the atmosphere of the sun, in order to explain the phenomenon. But there exists not even the faintest trace of a reason why they should not also appear on the photographs which give a much more exact image.

If Mr. Mayer maintains that he has observed such thorough and rapidly occurring changes in the intensity of radiation of different parts of the solar disc, the cause of them is not to be found on the sun himself, neither is it to be explained by local changes of the capability of absorption in the atmosphere

of the sun, nor by differences in the real temperature of different parts of the surface of the sun, we must rather look at present for the cause of them in the imperfection of the method.

Perhaps Mr. Mayer will find an opportunity of repeating his researches and will take occasion to neutralize in some degree the effect of the discoveries laid down in his five theses, which are apt to recall to memory the happily overturned mysterious state of solar physics, and might mislead any theorist in search of facts to the most venturous speculations.

Berlin: June, 1876. (Signed) DR. OSW. LOHSE.

SELENOGRAPHY—PAST, PRESENT, AND FUTURE.

By W. R. Birt, F.R.A.S.

Mr. Neison's letter in No. 159, p. 62, on "Lunar Nomenclature," has suggested various thoughts on the present condition and future prospects of Selenography, and these have been accompanied with others on its past condition, a true estimate of which can only be formed from its literature, embodying the results of the labours of its cultivators.

The cultivators of Selenography, at no period of its history, have been by any means numerous. It is, however, necessary in tracing its past history, clearly to understand what each writer means by using the term "Selenography." If only a delineation and description of the moon's surface be intended, then we go back to the epochs of Galileo, Hevel and Riccioli, but if something more be intended, as for example the study of the moon's surface with a view to detect any differences from the records of earlier observations, then we apprehend our starting-point must be Schröter. Let us endeavour to make our meaning plain. Most of our readers are aware that the earliest catalogue of stars originated in consequence of the observation of a star supposed to be new, other catalogues followed, and now we have several independent of each other, all serving the important purpose of identifying the positions of new and unexpected bodies which appear from time to time. As regards the more recent of these catalogues we should hardly be justified in regarding them as unwieldy or unmanageable; every astronomer is acquainted with their value; by comparing catalogues of double stars with the heavens, doubles before unknown have been added, and binaries have been assiduously watched. Applying this to Selenography as cultivated by Schröter, who was contemporary with the elder Herschel, it is notorious that the astronomy of double stars has made far

greater progress than the study of the moon's surface as originated by Schröter.

Mr. Neison speaks of Schröter's work as "practically of slight value to the selenographers of the present day, and it will be seldom indeed that the drawings and descriptions of this work will prove of any use in aiding observers at the present time in their study of the moon's surface." Mr. Neison's view of Schröter's work will of course depend on his views of Selenography generally. One thing is very certain, Schröter did not attempt to construct a lunar map, his *forte* was observation. It would appear, but we may be mistaken in our conclusion, that Mr. Neison's view of Selenography is the same as his predecessors have held, viz., the study of the moon as a whole, which may be regarded as wide of the true object as if it were possible to study double stars *as a whole,* and not observe and measure each pair separately, and keep some selected pairs under constant observation.* It is this dealing with the moon wholesale which has ever been a drawback to the progress of Selenography. "For general selenographical purposes," says Mr. Neison, "Schröter's two volumes of drawings and descriptions have been entirely superseded, and this will be the opinion of all who examine his, historically most interesting work, and compare them with the present needs of Selenography." What are the present needs of Selenography, and who are the Selenographers of the present day? We have many active amateur observers of double stars and binaries, but who among the 566 Fellows of the R. A. S. are steadily and persistently observing detail with a view to settle the vexed question of change on the moon's surface, a question that some influential Fellows have settled *authoritatively*, by declaring that in their opinion no change has taken place. It very seldom happens that the enunciation of views which are either of a novel character as the suspected change in *Linné* or not in accordance with the received opinions of the public are at once credited. They have to stand their trial, and evidence for and against must be adduced before they take their places as exponents of truth. In matters of science such trials are often very protracted, nothing can be authoritatively determined. There are, it is true, men who, having devoted much time and attention to the investigation of any particular branch of science, are entitled to be heard, but on the other hand there are men who, having also given attention to the same branch, and having arrived at a different

* The appearance of Mr. Neison's work on the Moon, since these lines were written, enables me to correct this idea. There are many important passages in this admirable work indicating the absolute necessity of fixing the attention by continued observation on special lunar features, with a view of ascertaining if any permanent changes occur.

and perhaps opposite conclusion, are entitled to be heard on the other side; on no account whatever should the views of either party be quietly shelved. Bearing in mind that no question in science can be settled by authority, the literature of the subject embodying the views of the opponents becomes the only record of its progress, and it is from its literature, alone that we can hope to derive true views of any subject which we desire to investigate. So far as Selenography and its literature are concerned, are there at the present time *six* Fellows of the R. A. S. steadily engaged in lunar work? Can we find any notices of such work in the last annual report of the Society?

As a general work of reference Schröter's has been found valuable in comparing his drawings, fragmentary though they be, with the moon, and we apprehend that no real progress can be made in Selenography without a constant reference to them for information as to the state of particular regions in his day.

Passing on to the epoch of Lohrmann and Mädler, so far as we can learn from a comparison of the works of these selenographers with that of Schröter's, there appears to be but little in common between them. Schröter observed with a definite object, whether he succeeded or failed is another matter. Both Lohrmann and Mädler had a definite object, that of constructing a lunar map, and their observations were subservient to this end, and the results of their labours, especially Mädler's, stand out as monuments of untiring and persevering industry, and in the solution of the question that has agitated astronomers of late years, their works must be consulted, although, as mentioned by a lucid writer, they both break down in detail. Who then would think of consulting them alone, and treat Schröter as obsolete? Strange to say, after the publication of Mädler's great map, the progress of Selenography appeared to have been retarded, for so far as we are aware nothing of any striking character was published between 1836 and 1851, when a feeble attempt was made to call the attention of English astronomers to Selenography, but it was so late as 1864 when for a few years some attention was really given to it.

As regards the suppression of Schröter's names by Mädler, we hold that a name once given should be sacredly retained, but it would be unwise now to restore Schröter's names and remove those of Mädler, or of any later selenographer when once established. There are, however, many of Schröter's which have been entirely suppressed by Mädler. We never heard, before reading Mr. Neison's letter, that the proposition has been urged to restore Schröter's names, and remove those which Mädler has substituted for them—the restoration of the suppressed names is another

thing which we know has been suggested—nor can we agree that the works of Schröter are practically effaced, except in the opinions of those gentlemen who have already settled the question of change.

Succeeding the epochs of Lohrmann and Mädler is that of Schmidt, who has committed to drawing the labours of thirty years. The non-publication of this great work speaks volumes as to the number of active observing selenographers, and so do the works of Schröter, Lohrmann, Mädler, and those published by Schmidt by remaining untranslated.* Hitherto English astronomers have taken but little interest in lunar matters, except in the production of photograms, a few hundreds having been taken. Of these it is to be regretted that scarcely any have been employed in studying the larger formations especially as they offer the means of scrutinizing them *at leisure*. If the 500 or more in existence had been carefully compared *inter se*, a rich harvest of results would have been secured during the last twenty years. Some attempts were made at the commencement of the decade 1850 to call attention to observational Selenography, and still later a well-known formation was under close and rigid observation by about half a dozen observers for a period of two years, the results having been published, since which the interest in Selenography appears to have subsided, and nothing of any moment has been effected since 1872.

In summing up the results of the past history of Selenography, we notice the earlier maps and labours of Galileo, Hevelius, Riccioli, Cassini, Lambert and Mayer, the numerous drawings and descriptions of Schröter, the two maps of Lohrmann and Mädler, the unpublished map of Schmidt, and the later English works, including the examination of the floor of Plato.

REVIEWS.

The Moon and the Condition and Configurations of its Surface. By Edmund Neison, Fellow of the Royal Astronomical Society, &c. Illustrated by maps and plates. London: Longmans, Green & Co. 1876.

At the sight of this volume with the name of Mr. Neison on the title-page, we anticipated an unusual treat in its perusal, and we have not been disappointed. It has 576 pages, and is divided into 29 chapters. Chap. I. is on the motions, figures, and dimensions of the moon. II. On the physical condition of the lunar surface. III. The lunar formations. IV. Lunar history. V. Variations of the surface. The above constitute the first division of the work. Chap. VI. with the key map is introductory to the 22 following, each of which has its own map. Chap. XXIX. is on selenographical formulæ, and this is succeeded by three tables, by synopsis of the formulæ, an alphabetical index to the formations, and

* We are glad to hear of the promised publication of Schmidt's map and also of the completion of Lohrmann's lectures.

finally, a general index. The illustrations comprise Copernicus (frontispiece), Day after sunrise, Agrippa and Godin, sunrise, Agrippa and Godin under meridional illumination, Plato soon after sunrise, Plato two days before full. The special maps, besides the 22 above mentioned, are Gassendi, Maginus, and Theophilus. The paper and type are excellent, and a red cloth binding with gilt letters gives the book a handsome appearance. Mr. Neison says the work was undertaken with a view of promoting the study of selenography, by supplying what has much been wanted, namely, a work on the Moon, which should treat of the present condition of the surface and deal with the configurations of the lunar crust with some degree of comprehensiveness. English selenographers have long felt the want of such a treatise on the moon, and its absence has been often urged as a main cause of the slow progress that has been made in the study of the phenomena presented by the moon. Hitherto the only work on this subject has been Beer and Mädler's "Der Mond," published forty years back, and, being in German, practically inaccessible to most English astronomers, besides standing much in need of revision and extension to bring it up to date. The "Mond" of Beer and Mädler has been taken as the basis of this work, and the labours of Schröter and Lohrmann have been used. The greater portion, however, of the material forming the present work is new, and has been mainly derived from eight years' selenographical observations. These were principally made with an excellent 6-inch equatorial of fine definition; but they have occasionally been made with refractors of smaller aperture, and towards the end with a nine and one-third inch With-Browning reflector of considerable excellence. These observations include a series of several hundred lunar sketches and drawings, which served as material for revising a considerable portion of the great lunar map of Beer and Mädler. For this purpose use has been also made of a collection of some hundred lunar sketches made of late years by different astronomers, and which from time to time have been sent to the author. These sketches have afforded information of great interest and value, which has been incorporated in the work. The author's thanks are especially due to the Rev. T. W. Webb for the general assistance he has received, and particularly for kindly placing at his service a long series of lunar observations. From this source much of great value has been derived. Much attention has been given to the question of the probable nature of the lunar surface, and stress has been laid on the view advanced, that the constitution of the earth and that of its satellite were primarily identical in nature. The view has also been strongly urged that the processes of modification their respective surfaces have undergone have been entirely analogous, and only modified in their results by the differences in physical dimensions between the two bodies. Many considerations have also been adduced as showing strongly that the moon possesses a real atmosphere of great mass and greater magnitude, though of slight density, and it has been pointed out that to neglect this is to render nugatory all attempts to explain the phenomena presented by the moon. To the mathematical portion of selenography much has been added, including nearly 400 measures of the position of points of the first order, the determination from some 200 measures of nearly 100 points of the second order, a considerable number of measures of the dimensions of different formations, and a number of determinations of the height of different lunar mountains. Most of Mädler's estimations of brightness have been revised, and a considerable number of new objects have had their brightness determined. The lunar map contains several thousand new objects, not included in Beer and Mädler's "Mappa Selenographica,"

including many new rills not contained in Schmidt's great catalogue "Der Rillen auf dem Mond." Several systems of long winding valleys, possessing an intimate connection with the lunar rills, have also been delineated in so far as the scale of the map rendered possible. In the final chapter a complete series of selenographical formulæ is given for the purpose of enabling observers to carry out the numerous series of micrometric measures that are required for the further progress of selenography.

Although of late powerful instruments have been employed in selenographical studies, those with less powerful instruments need not despair. Telescopes with apertures from three to five inches, if properly employed, may be made to yield work of the highest selenographical value, and are perfectly adequate to map and delineate the lunar surface in a manner that has not yet been approached either in accuracy or completeness. Even for the more recondite portions of selenography, namely, the determination of the positions and dimensions of lunar formations, telescopes with apertures from three to five inches are perfectly capable of being used for carrying out this work. Even if not provided with a clock-motion, or even if not equatoreally mounted, they can be made, by the aid of a properly constructed and inexpensive micrometer, to give the positions of the principal points of the moon's surface with a precision rivalling the results of Beer and Mädler. In fact, in general, instruments of the sizes referred to will find upon the moon better opportunities for doing valuable astronomical work than in any other direction, for the work to be done here is thoroughly within their grasp.

In conclusion, the author would be obliged by all corrections or extensions the text or maps may require, being communicated to him as soon as they are detected during further selenographical observations. Lunar drawings and observations would also be received with pleasure and acknowledged, so as to enable the results they may afford being incorporated in any future edition.

These extracts from the preface will afford a general idea of this important work, which not only in an admirable manner supplies a great want, but if we are not mistaken is likely to form an era in this department. Lunar study is indeed a field full of promise. If in many others gleanings alone remain, it cannot be said here that the harvest is nearly over. It is to be hoped that not a few possessors of good refractors and reflectors will be henceforth incited to unintermitted and careful observations; though even those which are desultory and isolated, accurately registered, may chance to have a value. We are sanguine enough to believe this will be the case. It is encouraging that almost simultaneously with the appearance of Mr. Neison's book, we hear of the completion of Lohrmann's map of the moon, three feet in diameter, under the supervision of Dr. Schmidt, and of the forthcoming publication of Dr. Schmidt's own great map of twice that diameter, the result of 34 years' labour. Those whose attention to our satellite may be either for the first time excited, or else further stimulated by these productions, have in such workers as Mr. Birt and Mr. Neison head-quarters where any communication will be turned to the best account. Besides the names already mentioned, references occur in the work before us to Gaudibert, Birmingham, Loder, Key, Knott, Knobel, Phillips, Kunowski, Ingal, and others, and there is room for many more contributors—abundance of work for the future.

Passing over for the present the intermediate chapters, we come to Chapter VI., introductory to the descriptive portion which is illustrated by a complete lunar map 24 inches in diameter, a size sufficiently great to enable every known object on the moon of any interest or importance to

be inserted. This map is divided into 22 sections, as shown by the key-map, and each section is separately described. To render each map entirely comprehensive and independent, the edges overlap to a considerable extent, thus obviating the inconvenience in consulting any of the other lunar maps, whether divided into quadrants or sections, from the formations at the edges appearing only in part. It has been found necessary in the more crowded portions of the surface to omit some of the very small and entirely unimportant details, very many of which on the more crowded portions of the great map of Beer and Mädler are not to be considered as representing actual features, but were inserted to represent the nature of the surface, and in place of the details which the instrumental means of B. and M. could not properly deal with. Throughout the most crowded portion of their great map such very small detail is entirely arbitrary and conventional. For the complete delineation of these very small irregularities of the surface, as low mounds, hillocks, ridges, and small peaks on the ridges, and walls of the ring-plains, &c., a scale of 100 inches to the moon's diameter is absolutely requisite, whilst to render these very minute features of any value, the lunar surface must be submitted to a far more searching investigation than it has ever yet received. We may say that these 22 maps are delightfully clear, and he names of the principal formations inscribed upon them makes reference very easy. Together with their respective descriptions they form a complete lunar gazetteer, complete, that is, to the extent of the best observations hitherto available. The general basis of the map is the great trigonometrical survey of the lunar surface of Beer and Mädler, which for the present must remain, as it hitherto has been, the foundation on which all lunar maps must be constructed. This great work requires a complete revision and extension, but cannot be touched in parts, as any alteration that may be made in one point implicitly affects the entire triangulation of the surface. On the small scale of the "Mappa Selenographica," and consequently on the map of this work, this is of minor importance, as the probable errors in the positions of Mädler are of comparatively small extent. The places on the present map have been, therefore, founded directly on Mädler without any alteration, except where absolutely requisite, but at the same time a very considerable number of new measures have been incorporated, giving the true position of many other formations whose places were not determined by Mädler. Though resting primarily on Beer and Mädler, the greater portion of the map has been revised by a long series of observations, including the results of several hundred drawings of the moon. Several thousand fresh objects have also been embodied, so that it contains a greater mass of detail than even the "Mappa Selenographica" of B. and M. Many hundred new rills have been inserted, a considerable number of which are absent from even the great catalogue of Schmidt, and they include almost every rill mentioned by Schmidt, the existence of many of his doubtful rills having been confirmed. The scale adopted in the special drawings or maps of certain selected formations, as Gassendi and Maginus, is somewhat over four times that of the general map, or one hundred inches to the moon's diameter. They show, therefore, these formations on a scale similar to the proposed map of the British Association, and nearly twice the area of the great map of Schmidt; yet this, as the drawings show, is only just adequate to give the principal minor details of the surface. These special maps are the results of long series of observations, and show all the details of those formations whose existence has been established, and whose nature has been distinctly made out. When compared with the great map of B. and M. which

shows within Gassendi, for instance, only a group of central mountains and a few mounds, or with the special drawings of Nasmyth, or even with the great map of Schmidt, many of whose objects require revision, they show the great field open before the real nature of the lunar surface is established. The general map or index is drawn to a scale of one-third the diameter of the principal map, and contains merely the chief formations together with the names of the greater number. The boundaries of the maps are shown by a dotted line.

The nomenclature employed is based on that of Beer and Mädler, as developed in their "Der Mond," as any alteration in this, which must be considered as the nucleus of any more extended system, would be most unadvisable. The principal later additions to the lunar names have been included. When it seemed advantageous new names have been added, selected from well known astronomers and mathematicians, but in especial selenographers. The original authorities for the 427 names employed by Beer and Mädler were as follows:—Hevel 6; Riccioli 206; Hell 1; Schröter 60; Lohrmann 8; Gruithuisen 1; and Mädler 145. From the new names included in the "British Associ tion Catalogue," 67 have been taken and added to Beer and Mädler's; the real authorities for these being:—Webb 1; Lecouterrier 1; Schmidt 1; Lee 4; and Birt 58; together with two of Schröter's early names not identified by Beer and Mädler. To these have been also added 19 more, consisting of 2 of Riccioli's and 3 of Schröter's restored, and 14 new names. Thus the grand total of named points on the moon is 513. After each name initial letters indicate the authority on which it rests. We think Mr. Neison has shown judgment in adding but few and well selected names, and these only when really advantageous; for it is not desirable to crowd the map of the moon unnecessarily with names; nor, as a general rule. should they now be chosen from any but the classes he mentions. The method of distinguishing the minor detail of the moon is essentially the same as that employed by Beer and Mädler; these small formations being symbolised by attaching a letter of the Greek or Roman alphabet to the name of the principal formation near.

The description of the formations on the lunar surface is to all intents new, for though completely embodying in a condensed form that of "Der Mond," it has in general been much extended and re-arranged. In most instances the description has been carefully revised in accordance with careful observations of the formations with far more powerful telescopic means than were at the disposal of B. and M., whilst in many cases it has been very materially extended by new details. It contains the material derived from a collation with the works of Schröter and Lohrmann, and in part with those of Schmidt and the British Association, together with the results of the observations of a number of years, and including a series of nearly one thousand sketches, drawings, &c., of the lunar formations. The entire results of the measures of Lohrmann, and Beer and Mädler, are given, together with a considerable number made during the last two years, thus presenting the entire *matériel* at present existing for constructing the ground-work of any lunar map. The estimates of the brightness of the surface and formations rest mainly on Mädler, but they have in the greater number of instances been confirmed by direct comparison with the lunar surface. A very considerable number of new determinations of the brightness of different points have been added, both by direct estimation and comparison with the neighbouring points, whose brightness had been determined by Mädler.

The special map of Gassendi has been founded on a series of nearly

fifty carefully executed drawings of this fine formation, made during the last six years with powerful instruments; and it contains the entire amount of detail whose existence may be regarded as definitely established. Gassendi is especially notable for the very intricate but fine system of rills on its interior, rendering it one of the most interesting formations upon the surface of the moon. This system comprises some thirty-eight rills, and, carefully studied, will throw much light on the real nature of these most interesting but inexplicable lunar features, so that they deserve the attention of all selenographers. Some of these rills may perhaps be doubtful, and others misplaced; for even in very powerful instruments they are most delicate and difficult features, and are rarely well seen.

The special map of that magnificent formation, Maginus, is founded on nearly twenty drawings, made at intervals during five years. It is the most complete map of this portion of the surface extant; and based on independent measures, its outline and general relation will be found entirely trustworthy, although not quite accordant with Mädler's. With few exceptions every feature delineated may be considered to have had its existence well established, though the difficulties in effecting this are, in this portion of the moon, far more formidable than in the more undisturbed regions towards the north. An especial feature to be noticed is the comparatively few crater-pits found within this grand walled-plain, though the surrounding regions contain very numerous members of this class.

The third special map is of the magnificent ring-plain, Theophilus, nearly sixty-four miles in diameter, with peaks of immense height on its walls, one of which rises to the tremendous altitude of 18,238 feet above the interior.*

We must now advert to the slightly tinted drawings, commencing with the frontispiece, Copernicus, the day after sunrise; being, as well as the others, on the same scale as the special maps, or 100 inches to the moon's diameter. This grand ring-plain has been figured in various works. As Webb remarks in the charming descriptive part of his "Celestial Objects," &c.; it is beautifully, though anonymously figured in Herschel II's "Outlines of Astronomy." There is also an exquisite drawing from Nasmyth in Lockyer's "Elementary Astronomy"; and another, also very fine from the same, in Smyth's "Speculum Hartwellianum," which also appears in Chamber's "Descriptive Astronomy." The style of all these is varied, and they all differ from that of the drawings in this volume, which, especially we find if held at a little distance from the eye, afford, perhaps, as vivid a representation of the reality as can well be produced; and are, we doubt not, reliable in all their features. The drawing of Godin and Agrippa under meridional illumination—a difficult work—is admirably executed; at first sight it looks like a drawing seen through tissue paper. The two views of Plato are equally excellent. Most persons, probably, who have enjoyed the enchanting views of lunar scenery, afforded even by telescopes of moderate aperture, have been surprised at the amount of what they can see, and at the same time the little, comparatively, that they can clearly interpret, and till taught by experience, the novice in moon-gazing is apt to fancy that there is hardly a limit to the magnifying power that might be applied. Arago, however, reminded his readers that with a power of 6,000 the mountains of the moon would appear of the size of Mont Blanc seen with the naked eye from the Lake of Geneva, and such

* Nearly the height of Elbrus in the Caucasus, and not much more than 600 feet less than Cotopaxi in the Andes.

a power is impracticable. As Webb remarks, the instruments or the nights are few indeed that will bear the sixth part of it; and when employed the moon would be seen as large (though not as distinct) as if it were 240 miles off. The power used in making the lunar drawings in this work we do not find stated. If we assume it was from 200 to 300, we may consider them, in a general way, as pictures of what the naked eye would behold at distances from 1,200 to 800 miles.

The Selenographical Formulæ embrace—1. Apparent co-ordinates of the moon. 2. Selenographical elements:—librations in longitude and latitude, and variations. Position of the pole and equator, and variation in position of the pole. 3. Selenographical elements (auxiliary). 4. Selenographical positions:—measurement and determination of the four classes of points, &c. 5. Selenographical dimensions:—measurement of height of mountains, diameters of formations, &c. Table I. is auxiliary quantities for the computation of the moon's librations. Table II. Points of the first order, with their positions and co-ordinates. Table III. Lunar elements. We hope to continue our notice of this book, in respect of the earlier chapters, in our next number, and meanwhile append a list (probably not complete) of misprints or misspellings observed in the course of our reading.

P. 139, "Maginius" (Maginus was a mathematician and astronomer of the 16th century).

P. 11, "minimum" (line 19) should be "mean." So p. 25.

The name of Firmicus Maternus (an astrologer of the the 4th century) is given as Firminicus, p. 146 (twice) 333, 149, and Ferminicus in the index.

Macrobius (grammarian, 4th century) appears as Macroibus, p. 205 (3 times), p. 206 (4 times), also in the index.

Eudoxus, written Eudoxes, p. 231 (4 times), 232 (twice), 220, 333. Also in map and index.

P. 235, the longitude of the crater Cassini G, given $+40° 41'$, should be $+4° 41'$.

Timæus (teacher and friend of Plato, and placed near him on the map) is spelled Timaus, p. 242 (3 times), 243 (3 times), 238, 250 (3 times).

Schiaperelli, pp. 270, 271, also map and index, for Schiaparelli.

Riphaen Mountains, for Riphæan, pp. 317, (twice), 348 (twice), 347, 349, 383. also index. But the word is more correctly spelled, Rhipæan, a mountain chain in some indefinite part of the north, as fancied by the Greeks. The name given by Mädler is, therefore, not well chosen to designate mountains not far from the moon's equator.

P. 317, "Galilai" should be Galilei, 320 (4 times), on map. (Galileo was his Christian name.)

P. 319, "enviorons," environs.

Ptolemäus, for Ptolemæus, p. 358 (twice), 359 (3 times), 360 (twice), index and map.

P. 389, Dopplemayer, for Doppelmayer (mathematician and astronomer of Nuremberg, 17th century).

Pingré, p. 409, and index, should be accented.

Baco, p. 441, (3 times), 447, should be Bacon, also index.

Haze, p. 459 (twice). and index, should be Hase.

"Almanon," p. 496 (4 times) and index. If this be, as we conclude it is, the Khaliph astronomer, it should be Almamon, or Al Mamun. This name is similarly misspelled in Webb's "Celestial Objects."

Hekatäus, pp. 515, 516, and index, The name of the distinguished geographer and historian (B.C. 500), who corrected and improved the map of the earth drawn by Anaximander is Hekatæus, or Hecatæus.

Putredinus, index,—Putredinis.

British Rainfall, 1875. *On the distribution of rain over the British Isles during the year 1875, as observed at about 1,800 stations in Great Britain and Ireland, with maps and illustrations.* Compiled by G. J. Symons, Secretary of the Meteorological Society, &c., &c. London: Edward Stanford, Charing Cross, S W. 1876 pp. 216. 5s.

The system of observing the rainfall owes its creation and development to Mr. Symons, as he says, during fifteen of the best years of his life. We are glad to find that, although there is much yet to be done, there were probably never so many stations in question as there are now, and the observations were never more carefully made, nor more vigorously checked. To meteorologists and all who study the weather with any care, this elaborate volume with its tables and records must needs be of great value. The verification of the latter occupies two persons constantly nearly two months, in addition to much work done out of the the office. The cessation of the grant of the British Association is rather regarded by Mr. Symons as a good thing, as though it throws upon him much extra expenditure, it leaves him free and unfettered. "If my friends," he says, "second my efforts by the accuracy of their records and by funds, we will earn a position far higher than any which the British Association, or even government itself, could give us." We hope the present supporters (and others too) of this valuable institution will even more than make up the extra 100*l*. required to meet the above-mentioned annual loss. The financial section, p. 21, concludes thus: "While, however, I should be able to do better work with more money, I am quite conscious that the sums entrusted to me, and acknowledged below, are a silent yet eloquent proof that an increasing body of my fellow-countrymen appreciate the work I have undertaken, and approve of my mode of conducting it."

Beobachtungen der Sonnenflecken II. *Herausgegeben von* Prof. Dr. G. Spörer. Leipzig, 1876. pp. 142, with 12 lithographic plates.

This is an elaborate series of observations on sun-spots and flaming protuberances, from Sept. 10th, 1867, to Oct. 9th, 1871. On plate 1 is a drawing of the remarkable groups of March 15th, 1870. These tables and the accompanying charts will be of great interest to those who are especially occupied with the study of the sun. In continuation of the former series, this one embraces the period of the 91st to the 145th rotation of the sun. Prof. Spörer's work appears to us to be of great value.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

VENUS.

Sir,—I think that I ought to say, in connection with the remarkably interesting letter by Mr. Green in the July number of the *Astronomical Register*, that I have myself only seen the unilluminated side of Venus when she has been in—or within a day or two on either side of—inferior conjunction.

I have (as I have repeatedly explained) constricted the field of view of my eye-piece by the insertion of a disc of card, in which a central hole has been punctured with a white-hot needle; and I have so regulated

the size of this aperture as to leave exceedingly little margin round the planet, when centrally placed in the field. Now, under these circumstances, I have seen the dark limb very unmistakably indeed; and my own idea has always been that this was in consequence of its projection upon that appendage of the sun (be it corona, zodiacal light, or what not) that extends to such a considerable distance from his sensible disc. I must add that I have wholly failed to perceive the smallest vestige of the unilluminated limb at other times, when Venus has been in quadrature, &c., and I have been observing in daylight; but that—as pointed out in a recent paper which I read before the Royal Astronomical Society—by waiting until the evening got dark enough, I could make a very beautiful and perfect pale blue phosphorescent limb, optically completing her circular outline, out of the minute amount of outstanding colour of a slightly over-corrected object-glass. This, however, differed, *toto cœlo*, from what I must still regard as the actual objective dark limb itself of the planet as seen in bright sunshine at the time of the inferior conjunction.

She came, as is well known, into that portion at 10 o'clock this morning, and, under these circumstances, I availed myself of an apparently clear sky to repeat my observation of her. I have just said that the sky was "apparently clear," but the glare of the sunshine on the object-glass of my telescope, a faint cirrus haze imperceptible to the naked eye, and atmospheric undulation generally materially interfered with good definition. I failed then to trace the dark limb round its outline, but I did see, without any doubt or dispute, that the space *within* the hair-like illuminated crescent was very distinctly darker than the sky outside the crescent. I asked my friend, the Rev. T. Wiltshire, F.G.S., &c., &c., &c., who is staying with me, to examine the planet, and see if he could detect a difference of shade anywhere; and after a short scrutiny his reply was, "I see that the space is certainly darker within the cusps than the surrounding firmament." I give his own words, because they are those of an observer who had no theory on the subject, and was not told and did not know what to look for.

I do hope that other astronomers have been availing themselves of the existing fine weather to endeavour to clear up the moot point of the visibility of Venus's unilluminated limb; and that the August number of the *Register* may contain other communications bearing upon this very curious question.

Meanwhile, I have the honour to be, sir, your most obedient servant,

Forest Lodge, Maresfield, Sussex: WILLIAM NOBLE.

1876, July 14.

NEW RED STAR.

I desire to call attention to a New Red Star found by me last April, which is one of the finest objects of the class I remember to have seen. It is brighter than most of the deep red stars, and has a blue 10 m. companion at a distance of about 77″ in the direction of 110°·2. It was recently observed by Dembowski, who calls it "a perfect blood red." He rates the magnitude 6·8. In Argelander it is called 8m., and in the Washington Catalogue 7·7. Like many other red stars, it may prove to be variable. It is Lacaille 5686, its place (1880) as follow:—

R. A. = 13h. 42m. 15s.
Decl. = − 27° 46′.

This star is not in Schjellerup's Catalogue of Red Stars.

Chicago: June 24th, 1876. S. W. BURNHAM.

SUSPECTED VARIABLE DOUBLE STAR.

Observers interested in Variable Stars may find an object worth

watching in No. 282 of my Fifth Catalogue of New Double Stars (*Monthly Notices*, Nov. 1874), now that it is coming within reach. At the time of the discovery of the companion I could not find this star, although one of the most prominent in the vicinity, in any of the Star Catalogues I had access to, and had to get its place from a neighbouring star, with the micrometer. I entered the magnitude of the principal star as 7, and companion 15 (Herschel's Scale). Dembowski has measured it on three nights, rating the larger twice as 6·5m., and once 7·0. The small star (distance 4″·2) he calls 12·0m. in two observations. This is in the Dorpat Scale, and corresponds to Herschel's 20m. It is a pretty good test for a 6-in. aperture, but bore sufficient illumination for a measure of the angle with my instrument. The absence of so bright a star from all the Star Catalogues of Weisse, Lalande, Rümker, Schjellerup, B. A. C., Bode, and others, would be ground for suspecting variability. And further evidence is afforded by finding it in one of Lamont's Catalogues (No. 2082 of *Verzeichniss von* 4093 *telescopischen Sternen zwischen* —9° *und* — 15° *Declination*, 1872) where it is given as fifth magnitude!

The place (1880) is:—

R. A. = 17h. 8m. 29s.
Decl. = — 14° 27′.

It will be readily found without circles.

Chicago: June 24th, 1876. S. W. BURNHAM.

HALOS.

Though rather late in the year the following summary of halos may be interesting to some of your readers:—

1875	Halos. *Solar*.	Mock suns.	Thunder or Lightning.
January ...	10 ...	4 ...	2
February ...	4 ...	0 ...	0
March ...	9 ...	1 ...	0
April ...	8 ...	0 ...	1
May ...	13 ...	1 ...	1
June ...	9 ...	0 ...	7
July ...	8 ...	0 ...	5
August ...	11 ...	0 ...	7
September ...	9 ...	2 ...	7
October ...	8 ...	3 ...	4
November ...	5 ...	3 ...	0
December ...	2 ...	0 ...	0

Solar Halos, 96. Lunar Halos, 13. Mock suns, 14. Rainbows, 25. Days on which Rain or Snow fell, 209. Rainfall, 26 inches. I saw no auroral streams, but seven times I noticed a light in the north, which appeared to be auroral. Zodiacal light almost every clear dark evening from January to May 2nd, and again a few times towards winter.

I saw the conjunction of Jupiter and β Scorpii last February, about 5 a.m., when the star appeared to touch the limb of Jupiter, and at times was quite invisible with a power of 144 on my 4½-inch reflector. This could hardly be owing to the slight unsteadiness of the atmosphere as β was so much brighter than the limb of the planet.

Writtle, Essex. H. CORDER.

VENUS.

Sir,—I made several careful measurements of Venus at the late inferior conjunction, and found a prolongation of the cusps to a degree that quite surprised me. In fact the measure from a line joining the cusps to the

limb was nearly, if not quite, three-fourths the of full diameter. Of course I expected a certain prolongation, but not to so great an extent as this, though, in fact, it may be no greater than what has been seen by previous observers of whose measurements I am ignorant.

J. BIRMINGHAM.

LUNAR OBJECTS SUITABLE FOR OBSERVATION IN AUGUST, 1876.

By W. R. Birt, F.R.A.S., F.M.S.

With the hope that the lunar formation "Fracastorius" may furnish material for useful study of a character—if not similar to that which occupied the attention of selenographers when engaged with the floor of Plato—at least of sufficient interest to lead to further discoveries, either of minute objects on its surface not recognised before, or variations in the aspects and appearances of such as have long been the subjects of observation, we beg to direct the attention of observers to a few more objects, forming a continuation of the "Synopsis" from which we quoted in our lists for April last, p. 97, and in that for June, p. 147.

X. A ridge connecting the northern extremity of the east wall with a shallow crater on the northern boundary of "Fracastorius."

On the 29th of April a drawing of "Fracastorius," by the Rev. J. B. Richards, of Bayswater, came to hand, it is dated "28 April, 1876, about 8 p.m." In this drawing this ridge is very distinctly delineated, and so far as I remember it was then quite new to me, as I have no recollection of having seen it previously, nor have I it on any of the drawings of earlier date in my possession. From a communication to the *English Mechanic* of June 30, 1876, p. 405, by M. Gaudibert, it appears that this gentleman observed "Fracastorius" on the same evening with his 8½-in. mirror; he gives a sketch in which the ridge appears, and he specifies that it consists of three distinct hillocks, and it has on the north-east side two craterlets. 28 hours 45 minutes later than the epoch of the drawing by the Rev. W. Richards, Mr. Simms observed and sketched "Fracastorius," he also gives this ridge. I first obtained an observation of it on May 28, 7 p.m., when I made a sketch of "Fracastorius;" the ridge appeared precisely as given by the Rev. W. Richards. I next saw it distinctly with Mr. Barclay's refractor of 10 inch aperture on June 27, the night was not over favourable, I however noticed that the ridge had a very narrow crest. On the night of July 3, 1876, I have the following record: "The northern boundary of 'Fracastorius' is very decidedly angular at the shallow crater XI. of the synopsis. There is not the slightest appearance of Simms' two bays."

XI. The shallow crater mentioned under X.

This crater was first seen by Birt on September 22, 1868, it is mentioned in the article on "Fracastorius," *English Mechanic*, Sept. 16, 1870; it was seen by Birmingham, 1871, January 10, who places within it a small crater or craterlet: it was sketched by Richards, 1876, April 28, and by Birt, 1876, May 28; there is consequently no doubt of its existence, it is however curious that this shallow crater should have been seen at intervals from Sept. 22, 1861, to April 28, 1876, while the ridge connecting it with the eastern border should have escaped notice. Drawings of "Fracastorius," especially of the northern border, will be very acceptable for comparison with those which I have bearing earlier dates; attention may also be given to the colour of the floor of "Fracastorius" within the northern border, and that of the Mare Nectaris exterior to it.

Errata in former lists:—April, p. 97, delete comma after the word "least" in line 3. May, p. 122, fourth line from the bottom of page, for *contained* read *continued*.

ASTRONOMICAL OCCURRENCES FOR AUGUST, 1876.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Altair.
Tues	1		Sidereal Time at Mean Noon, 8h. 41m. 44·65s.	2nd Sh. I. 2nd Tr. E. 1st Oc. D.	9 3 9 5 9 57	— 11 1·2
Wed	2		Sun's Meridian Passage 5m. 58·07s. after Mean Noon	1st Sh. I. 1st Tr. E. 1st. Sh. E.	8 25 9 22 10 38	10 57·3
Thur	3		Saturn's Ring: Major axis=42″·47 Minor axis=5″·16	1st Ec. R.	7 51 24	10 53·4
Fri	4	18 37 13	○ Full Moon Superior conjunction of Mercury and Sun			10 49·4
Sat	5					10 45·5
Sun	6	17 8 18 3 6 17	Occultation of Saturn Reappearance of ditto Conjunction of Mars and Mercury, 0° 38′ N. Conjunction of Moon and Saturn 0° 38′ S.			10 41·5
Mon	7	9 43 13 30 15 10	Near approach of ϕ Aquarii (4½) Near approach of 96 Aquarii (5½) Near approach of B.A.C. 8134 (6½)			10 37·6
Tues	8			2nd Tr. I. 3rd Sh. I.	9 1 9 6	10 33·7
Wed	9			1st Tr. I.	9 3	10 29·8
Thur	10	12 28	Near approach of π Piscium (6)	2nd Ec. R. 1st Ec. R.	8 46 59 9 46 10	10 25·8
Fri	11	15 44 16 46	Occultation of B.A.C. 782 (6½) Reappearance of ditto			10 21·9
Sat	12	9 58 15 3 15 10 8 13	☾ Moon's Last Quarter (6½) Occultation of 66 Arietis (6½) Reappearance of ditto Conjunction of Uranus and Sun Conjunction of Mars and Sun			10 17·9
Sun	13	12 19 12 41	Occultation of χ^1 Tauri (5½) Reappearance of ditto			10 14·0
Mon	14	16 9	Near approach of B.A.C. 1746 (6½)			10 10·1

DATE.		Principal Occurrences. h. m.		Jupiter's Satellites.	h. m. s.	Meridian Passage h. m.
Tues	15	8	Jupiter at quadrature with the Sun Illuminated portion of disc of Venus=0·229 Illuminated portion of disc of Mars=1·000	3rd Tr. I. 3rd Tr. E.	7 50 10 2	10 6·1
Wed	16	5	Conjunction of Moon and Venus 10° 38′ S. Sidereal Time at Mean Noon, 9h. 40m. 52·99s.			10 2·2
Thur	17		Sun's Meridian Passage 3m. 45·35s. after Mean Noon	1st Oc. D. 2nd Oc. R. 2nd Ec. D.	8 13 8 48 8 50 41	9 58·3
Fri	18	20	Conjunction of Moon and Mars 1° 12′ S.	1st Tr. E. 1st Sh. E.	7 40 8 58	9 54·3
Sat	19	0 25 20	● New Moon Venus at greatest brilliancy			9 50·4
Sun	20	2	Conjunction of Moon and Mercury 0° 22′ N.			9 46·5
Mon	21					9 42·5
Tues	22					9 38·6
Wed	23		Saturn's Ring: Major axis=42″·88 Minor axis=5″·73			9 34·7
Thur	24			2nd Oc. D.	8 51	9 30·7
Fri	25	14	Conjunction of Moon and Jupiter 5° 42′ N.	1st Tr. I. 1st Sh. I.	7 23 8 40	9 26·8
Sat	26	6 17	☽ Moon's First Quarter	3rd Ec. D. 1st Ec. R. 1st Sh. E. 3rd Ec. R.	7 18 32 8 4 22 8 41 9 10 20	9 22·9
Sun	27	5	Opposition of Saturn and Sun			9 18·9
Mon	28	9 39 10 46	Occultation of B.A.C. 6107 (4) Reappearance of ditto			9 15·0
Tues	29					9 11·1
Wed	30					9 7·1
Thur	31					9 3·2
SEPT. Fri	1					8 59·2

THE PLANETS FOR AUGUST.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	8 41 46	N.19 56½	5″·0	23 56·1
	9th	9 39 28	N.15 52	5″·0	0 26·1
	17th	10 36 53	N.10 9½	5″·0	0 51·9
	25th	11 26 10	N. 4 10	5″·2	1 9·6
Venus ...	1st	6 58 12	N.16 4	48″·7	22 12·8
	9th	6 59 58	N.16 22½	44″·3	21 43·1
	17th	7 10 57	N.16 44½	38″·2	21 22·6
	25th	7 29 7	N.16 57½	33″·7	21 9·3
Jupiter ...	1st	15 20 51	S. 17 35½	36″·7	6 38·0
	9th	15 22 30	S. 17 43½	35″·8	6 8·2
	17th	15 24 52	S. 17 54½	34″·9	5 39·1
	25th	15 27 56	S. 18 7	34″·3	5 10·7
Saturn ...	1st	22 35 53	S. 10 48	17″·0	13 51·9
	9th	22 33 54	S. 11 1	17″·0	13 18·4
	17th	22 31 45	S. 11 14½	17″·2	12 44·8
	25th	22 29 29	S. 11 28½	17″·2	12 11·1

Mercury rises about a quarter of an hour before the sun at the beginning of the month, the interval decreasing. He may be observed a quarter of an hour after sunset on the 6th, the interval increasing to about half-an-hour after sunset.

Venus is visible two hours and a quarter before sunrise on the 1st, the interval decreasing to an hour and a half.

Jupiter sets an hour before midnight, at the beginning of the month, and then earlier each night. On the last day he sets soon after 9 p.m. He is at quadrature with the sun on the 15th.

Saturn rises soon after sunset on the 1st, the interval decreasing.

EPHEMERIS FOR PHYSICAL OBSERVATIONS OF JUPITER.

8h. *) Greenwich. M. T.	Longitude of ♃'s central merid.		Angle of position of ♃'s axis.	Annual parallax.	Latitude of earth		sun above ♃'s equator.
1876.	°	°	°	°	°	°
Aug. 1	350·4	870·5	15·27	10·67		
2	140·9	·5	15·26	10·70		
3	291·4	·5	15·24	10·73	—2·92	—2·90
4	81·9	·5	15·22	10·76		
5	232·4	·4	15·20	10·79		
6	22·8	·5	15·18	10·81		
7	173·3	·5	15·16	10·84		
8	323·8	·4	15·14	10·86	—2·91	—2·89
9	114·2	·5	15·12	10·87		
10	264·7	·5	15·10	10·89		
11	55·2	·4	15·07	10·90		
12	205·6	·5	15·05	10·91		

13	356·1	·4	15·02	10·91	—2·90	—2·87
14	146·5	870·4	14·99	10·91		
15	296·9		14·96	10·91		

*) 8h. Gr. M. T. At page 173, "Greenwich midnight" has been erroneously printed for 8h. Gr. M. T. The MSS. was correct.

A. M.

SATELLITES OF SATURN.

Approximate Greenwich sidereal times of conjunctions and elongations occurring between 16h. and 4h. Greenwich sidereal time.

f. conj. with following edge of ring. n. north of ring.
p. „ „ preceding „ „ s. south „
sup. superior conj. with centre of ball. e. greatest eastern elongation.
inf. inferior „ „ w. „ western „

1876.	Gr. Sid. Time. h		
Aug. 1	17·2	Tethys.	nf.
	18·8	Mimas.	w.
	19·4	Titan.	inf. 23″ s.
	20·0	Dione.	nf.
	20·3	Encel.	w.
	1·1	Tethys.	e.
	1·3	Encel.	np.
2	15·9	Tethys.	sp.
	16·7	Rhea.	sp.
	17·5	Mimas.	e.
	17·8	Encel.	sf.
	21·2	Dione.	sf.
	23·8	Tethys.	w.
	0·2	Encel.	sp.
3	16·2	Mimas.	e.
	16·7	Encel.	nf.
	17·5	Dione.	w.
	21·7	Encel.	e.
	22·5	Tethys.	e.
	2·8	Encel.	sf.
	3·5	Mimas.	w.
4	18·5	Rhea.	sup. n.
	19·3	Encel.	np.
	01·2	Tethys.	w.
	23·0	Rhea.	nf.
	? 1·6	Iapetus	inf. 29″ n.
	1·7	Encel.	nf.
	2.2	Mimas.	w.
	2·4	Dione.	e.
5	18·1	Encel.	sp.
	19·9	Tethys.	e.
	21·6	Rhea.	e.
	22·7	Dione.	sp.
	23·2	Encel.	w.
	0·9	Mimas.	w.
	3·8	Tethys.	sf.
6	18·6	Tethys.	w.
	20·3	Rhea.	sf.
	20·7	Encel.	sf.

1876.	Gr. Sid. Time. h		
	23·6	Mimas.	w.
	23·9	Dione.	np.
	0·8	Rhea.	inf. s.
2·2h. Occultation by the Moon.			
	2·5	Tethys.	np.
	3·1	Encel.	sp.
7	19·6	Encel.	nf.
	20·3	Dione.	e.
	22·2	Mimas.	w.
	0·6	Encel.	e.
	1·2	Tethys.	sf.
	4·0	Rhea.	w.
8	16·1	Tethys.	w.
	16·6	Dione.	np.
	17·1	Encel.	w.
	20·9	Mimas.	w.
	22·2	Encel.	np.
	0·0	Tethys.	np.
	2.6	Rhea.	np.
9	17·8	Dione.	np.
	19·6	Mimas.	w.
	21·0	Encel.	sp.
	22·7	Tethys.	sf.
	1·5	Dione.	nf.
	2·1	Encel.	w.
10	18·3	Mimas.	w.
	18·6	Encel.	e.
	21·4	Tethys	np.
	23·6	Encel.	sf.
	2·7	Dione.	sf.
11	16·1	Encel.	np.
	16·9	Mimas.	w.
	17·9	Rhea.	sp.
	20·1	Tethys.	sf.
	22·5	Encel.	nf.
	23·0	Dione.	w.
	3·0	Tethys.	sp.
	3·5	Encel.	e.
12	16·6	Rhea.	w.

1876.	Gr. Sid. Time. h.		
	18·8	Tethys.	np.
	19·3	Dione.	nf.
	20·0	Encel.	w.
	1·1	Encel.	np.
	1·7	Tethys.	nf.
	3·0	Mimas.	e.
13	17·5	Tethys.	sf.
	17·6	Encel.	sf.
	19·7	Rhea.	sup. n.
	20·5	Dione.	sf.
	23·9	Encel.	sp.
	0·2	Rhea.	nf.
	0·4	Tethys.	sp.
	1·6	Mimas.	e.
14	16·2	Tethys.	np.
	16·4	Encel.	nf.
	16·8	Dione.	w.
	21·5	Encel.	e.
	22·9	Rhea.	e.
	23·1	Tethys.	nf.
	0·3	Mimas.	e.
	2·5	Encel.	sf.
15	19·0	Encel.	np.
	21·5	Rhea.	sf.
	21·8	Tethys.	sp.
	23·0	Mimas.	e.
	1·4	Encel.	nf.
	1·8	Dione.	e.
	2·1	Rhea.	inf. s.
16	17·9	Encel.	sp.
	20·5	Tethys.	nf.
	21·7	Mimas.	e.
	22·1	Dione.	sp.
	22·9	Encel.	w.
	4·0	Encel.	np.
17	16·6	Titan inf. 25″ s.	
	19·2	Tethys.	sp.
	20·3	Mimas.	e.
	20·5	Encel.	sf.
	23·3	Dione.	np.
	2·8	Encel.	sp.
	3·1	Tethys.	w.
	3·9	Rhea.	np.
18	18·0	Tethys.	nf.
	19·0	Mimas.	e.
	19·3	Encel.	nf.
	19·6	Dione.	e.
	0·4	Encel.	e.
	1·8	Tethys.	e.
19	15·9	Dione.	sp.
	16·7	Tethys.	sp.
	16·9	Encel.	w.
	17·7	Mimas.	e.
	21·9	Encel.	np.

1876.	Gr. Sid. Time. h.		
	0·2	Tethys.	nf.
	0·6	Tethys.	w.
20	16·4	Mimas.	e.
	17·1	Dione.	np.
	19·2	Rhea.	sp.
	20·8	Encel.	sp.
	23·3	Tethys.	e.
	0·8	Dione.	nf.
	1·8	Encel.	w.
	3·7	Mimas.	w.
21	17·8	Rhea.	w.
	18·3	Encel.	e.
	22·0	Tethys.	w.
	23·4	Encel.	sf.
	2·0	Dione.	sf.
	2·4	Mimas.	w.
22	16·5	Rhea.	np.
	20·7	Tethys.	e.
	21·0	Rhea.	sup. n.
	22·2	Encel.	nf.
	22·3	Dione.	w.
	1·1	Mimas.	w.
	1·5	Rhea.	nf.
	3·3	Encel.	e.
23	18·7	Dione.	nf.
	19·4	Tethys.	w.
	19·8	Encel.	w.
	23·7	Mimas.	w.
	0·1	Rhea.	e.
	0·8	Encel.	np.
	3·3	Tethys.	np.
24	17·3	Encel.	sf.
	18·1	Tethys.	e.
	19·9	Dione.	sf.
	22·4	Mimas.	w.
	22·8	Rhea.	sf.
	23·7	Encel.	sp.
	2·0	Tethys.	sf.
	3·3	Rhea.	inf. s.
	3·6	Dione.	sp.
25	16·2	Encel.	nf.
	16·2	Dione.	w.
	16·8	Tethys.	w.
	21·1	Mimas.	w.
	21·2	Encel.	e.
	0·7	Tethys.	np.
	2·3	Encel.	sf.
26	18·7	Encel.	np.
	19·8	Mimas.	w.
	23·4	Tethys.	sf.
	1.1	Dione.	e.
	1·1	Encel.	nf.
27	17·6	Encel.	sp.
	18·4	Mimas.	w.

1876.	Gr. Sid. Time.		
	h.		
	21·4	Dione.	sp.
	22·1	Tethys.	np.
	22·7	Encel.	w.
	3·7	Encel.	np.
28	17·1	Mimas.	w.
	20·2	Encel.	sf.
	20·8	Tethys.	sf.
	22·6	Dione.	np.
	2·6	Encel.	sp.
	3·7	Tethys.	sp.
29	15·9	Rhea.	inf. s.
	18·9	Dione.	e.
	19·1	Encel.	nf.
	19·5	Tethys.	np.
	20·4	Rhea.	sp.
	0·1	Encel.	e.
	2·4	Tethys.	nf.
	3·1	Mimas.	e.
30	16·6	Encel.	w.
	18·2	Tethys.	sf.
	19·1	Rhea.	w.
	21·6	Encel.	np.

1876.	Gr. Sid. Time.		
	h.		
	1·2	Tethys.	sp.
	1·8	Mimas.	e.
	3·8	Dione.	w.
	4·0	Encel.	nf.
31	16·4	Dione.	np.
	16·9	Tethys.	np.
	17·7	Rhea.	np.
	20·5	Encel.	sp.
	22·2	Rhea.	sup. n.
	23·9	Tethys.	nf.
	0·1	Dione.	nf.
	0·5	Mimas.	e.
	1·6	Encel.	w.
	2·7	Rhea.	nf.
Sept. 1	18·0	Encel.	e.
	22·6	Tethys.	sp.
	23·1	Encel.	sf.
	23·1	Mimas.	e.
	1·3	Dione.	sf.
	1·4	Rhea.	e.
2	16·6	Titan.	inf 27″ s.

Differences of right ascension and declination of Titan and Iapetus and of the centre of Saturn. For oh. Gr. Sider. Time.

	Titan.		Iapetus.	
	α—A.	δ—D.	α—A.	δ—D.
	s.	″	s.	″
Aug. 1	—1·12	—21·7	+8·94	+33·0
2	5·91	12·5	6·08	30·6
3	9·80	—1·3	3·17	27.9
4	12·11	+10·2	+0·24	25·1
5	12·44	20·1	—2·70	22·2
6	10·69	26·7	5·63	19·1
7	7·15	29·0	8·53	16·0
8	—2·42	26·5	11·39	12·8
9	+2·68	19·8	14·18	9·5
10	7·42	+9·9	16·89	6·2
11	11·03	—1·5	19·51	+2·9
12	13·03	12·8	22·01	—0·4
13	13·17	22·4	24·38	3·7
14	11·44	28·9	26·61	6·8
15	8.10	31·4	28·69	9·9
16	+3·60	—29·4	—30·60	—12·9
17	—1·43	23·2	32·32	15·8
18	6·24	13·5	33·85	18·6
19	10·08	—1·6	35·17	21·2
20	12·31	+10·7	36·28	23·6
21	12·50	21·2	37·17	25·8
22	10·61	28·3	37·82	27·8
23	6·95	30·8	38·24	29·6
24	—2·14	28·2	38·43	31·2
25	+3·02	21·1	38·37	32·5
26	7·72	+10·7	38·06	33·6
27	11·26	—1·4	37·51	34·4

28	13·16	13·4	36·73	35·0
29	13·17	23·6	35·71	35·4
30	11·32	30·5	34·45	35·3
31	7·87	33·2	32·97	34·8
Sept. 1	+3·30	—31·1	—31·27	—34·2

To find the places of the five inner satellites, the values of their elongations given in the following table must be interpolated for the time required:

0h. Greenwich Sidereal Time.

1876.	Mimas. l.	diff.	Encel. l.	diff.	Tethys. l.	diff.	Dione. l.	diff.	Rhea. l.	diff.
Aug.	°	°	°	°	°	°	°	°	°	°
3	213·8	1905·1	114·6	1310·4	101·6	951·3	305·5	656·2	298·7	397 7
8	318·9	·2	345·0	·4	332·9	·2	241·7	·2	336·4	·7
13	64·1	·1	215·4	·5	204·1	·2	177·9	·2	14·1	·7
18	169·2	·1	85·9	·4	75·3	·2	114·1	·2	51·8	·7
23	274·3	·1	316·3	·4	306·5	·3	50·3	·2	89·5	·7
28	19·4	1905·1	186·7	1310·4	177·8	951·2	346·5	656·2	127·2	397·7
Sept.										
2	124·5		57·1		49·0		282·7		164·9	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
Aug.	″	″	″	″	″	″	″	″	″	″
3	29·0	3·5	36·3	4·4	46·0	5·6	58·9	7·2	82·3	10·0
8	29·1	3·6	36·4	4·6	46·2	5·8	59·1	7·4	82·6	10·3
13	29·1	3·7	36·5	4·7	46·3	5·9	59·3	7·6	82·8	10·6
18	29·2	3·8	36·6	4·8	46·4	6·1	59·4	7·8	83·0	10·9
23	29·2	3·9	36·7	4·9	46·4	6·2	59·5	8·0	83·1	11·1
28	29·2	4·0	36·7	5·0	46·4	6·4	59·5	8·2	83·1	11·4
Sept.										
2	29·2	4·1	36·6	5·1	46·4	6·5	59·5	8·3	83·0	11·7

a and b are the semi-axes of the apparent orbits. The rectangular co-ordinates x'', y'' of the satellites, reckoned parallel to the axes of the ring, are then found by $x'' = a \sin l$, and $y'' = b \cos l$, and the polar-co-ordinates p and s by

$$s \sin (p - 6°{\cdot}0) = a \sin l.$$
$$s \cos (p - 6°{\cdot}0) = b \cos l.$$

A. MARTH.

Errata in July number.—By an inadvertance the Phases of the Moon for *August* were erroneously inserted. Page 165, 11 lines from end, for *of the* experiment, read *after*.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To Feb., 1876.
Darby, Rev. W. A.

To March, 1876.
Jackson-Gwilt, Mrs. H.

To July, 1876.
Jenkinson, Rev. J. H.

To Sept., 1876.
Rivas, Miss.

To Dec., 1876.
Baffham, T.
Corder, H.
Metcalfe, Rev. W. R.

To June, 1877.
Hankey, H. A.

To July, 1877.
Ennis, J.
Herschel, Major J.
Thomas, J. H.

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The pages of the *Astronomical Register* are open to all suitable communications Letters, Articles for insertion, &c., must be sent to the Rev. J. C. JACKSON, *Clarence Road, Clapton, E.*, **not later than the 15th of the Month.**

The Astronomical Register.

No. 165. SEPTEMBER. 1876.

ON THE POSITION OF SCHROETER WITH REGARD TO SELENOGRAPHY OF THE PRESENT TIME.

By E. Neison.

How far is the study of the very numerous and detailed observations of different portions of the moon, and of the many elaborate special drawings of different lunar regions contained in the two bulky volumes by Schröter, entitled "Selenotopographical Fragments," indispensable to the selenographer of the present time? is a question on which apparently opinions differ, but it is one which may be not unprofitably discussed, for it is discouraging in the extreme to be informed that the study of the works of a particular author, if not indisputable, is of the greatest importance, when the works of that author are accessible to only a few metropolitan workers. My own opinion has been already expressed on the present position of Schröter's works with regard to selenography, and it is to the effect that, for general purposes, Schröter's numerous drawings, with their elaborate and lengthy descriptions, have been entirely superseded by the works of Lohrmann and Mädler. It must be remembered that the above applies only to selenographical purposes, for it is not to be disputed that for certain particular purposes, reference to the drawings and descriptions of Schröter may be indispensable, but these are purely exceptional instances.

This view having been questioned by Mr. Bird, in an article entitled "Selenography, Past, Present, and Future" (ASTRONOMICAL REGISTER, Aug., 1876), it is desirable that the grounds for the above view should be stated, so as to enable lunar observers to form their own conclusions on the question, whether additional information of importance will be gained by referring past Beer and Mädler and Lohrmann to the works of Schröter. Before, however, doing this, attention must again be drawn to the fact that this is a subject entirely apart from the great services rendered by Schröter to selenography. The view that Schröter's works have now been superseded by those of later selenographers cannot justly in any manner be held to be depreciatory of the great work achieved by him. And, despite the hostile criticism of his works by Beer and Mädler, Schröter's name will always live as that of the real founder and most arduous worker on selenography.

Though Schröter possessed an instrument of size, and perhaps power far exceeding those employed by Beer and Mädler, and by Lohrmann, a careful and impartial examination of his drawings as compared with the drawings of his great successors, Lohrmann and Beer and Mädler, will show that it is rarely he draws details which are not to be found in the maps of Lohrmann and Beer and Mädler. And where any difference or discrepancy is found to exist between his drawings and those of his successors, it will be found that, with very rare exceptions, the later astronomers are correct. Nor is this to be wondered at, for as they possessed his drawings, if any discrepancy between the two occurred, it naturally led to a further examination by Lohrmann and Beer and Mädler, which enabled them to ensure the correctness of their drawings. In consequence of this, therefore, it is very rarely that reference to Schröter's drawings or descriptions will give any information which is not at once to be derived from the works of Lohrmann or Beer and Mädler, so that when the in general great accuracy of Beer and Mädler's delineation of the principal features is remembered it will be evident that reference to Schröter's works for information, that has been already obtained from Beer and Mädler, is perfectly unnecessary. That is, in fact, equivalent to what has been stated, that Schröter's work has been superseded in this respect by the generally accessible works of Beer and Mädler.

Now, leaving the larger features, consider the small features or details presented by the different lunar formations. It is known that the works of Lohrmann, and in particular of Beer and Mädler, present a considerable quantity of this detail. Experience has also shown that though this detail is usually tolerably

faithful, it occasionally, or in fact in certain regions, often breaks down in the accuracy of the smaller features. Could, then, Schröter's drawings and descriptions be relied upon as furnishing trustworthy delineations of the real nature of the detail, his works would be unquestionably of the very greatest importance to the selenographer of the present time. So far, however, from this being the case, it is rarely that Schröter furnishes any information at all with regard to details of this nature, and only towards the end of his drawings will any details of this class be found. They appear, in fact, to have been beyond the power of his instruments, which broke down in the definition of such small features. With the exception of a dozen or so instances, therefore, if in the minor detail of the moon a feature is not found on Beer and Mädler's map, it will for a certainty not be found on Schröter's drawings. In fact, of the minute details of the lunar surface, it may be broadly stated that Schröter shows nothing, and it is in these features alone that Beer and Mädler are anywhere seriously at fault. This, then, establishes the position already taken, that it is in general useless to refer beyond Beer and Mädler's map and description to the drawings of Schröter for additional information, or in other words that Schröter's works have been superseded by the far more complete and generally accessible works of Beer and Mädler.

There are, of course, as already mentioned, occasions when reference to the works of Schröter will be indispensable, and there are other instances where all the observations of Schröter will be found the best and most complete information on the subject. Of the former, cases of suspected variation in the lunar surface may be taken as an instance. Thus, suppose at some future period it should be found that some prominent or conspicuous crater or mountain should vanish, as in the case of Linné or alter in form as in the case of Messier, reference to Schröter's works would then obviously be indispensable to see whether he had drawn this region, and if so how he had delineated it. This must, however, be regarded as a very exceptional circumstance.

Again, the drawings and descriptions of Schröter's with regard to the great range of mountains on the limb present the best existing account of these formations, and to a selenographer who had taken these as a special point of study, reference to Schröter's works would be of the greatest advantage. This again is, however, an exceptional instance, for the study of these regions of the moon on the very limb and its borders, presents the greatest difficulties, and requires the most inexhaustible patience, whilst it is only telescopes of the highest perfection that are capable of the work.

For general selenographical work, however, which may be taken to be the delineation of one or more regions upon the moon, and the careful study and mapping of the same, it will be found that Lohrmann, or Beer and Mädler must be taken as the basis of the work, and that reference past them to Schröter will very rarely, if ever, be found to repay the labour, whilst for ninety-nine per cent. of the work to be done, after the first delineation of the main feature, it will be found that reference to any authority will be made without any aid being obtained.

Closely related to the subject already referred to stands that with reference to Schröter's nomenclature. In the course of his labours, Schröter named a very considerable number of different formations, somewhere between seventy and eighty in number, but without any systematic method. In consequence of this he often attached a single name to two or more different formations, usually closely situated, it is true, whilst in other cases he named a region possessing little, if any, natural boundaries, and therefore little suited for the purpose of being named. When Beer and Mädler came to map the moon, though they in general left Schröter's names unaltered, in some ten to fifteen cases falling principally into the category of unsatisfactory instances already referred to, Beer and Mädler dealt very roughly with Schröter's handiwork, which they modified and altered until they brought it into a more satisfactory condition. Finally, Beer and Mädler passed entirely over certain of Schröter's names. Out of, therefore, the seventy or eighty names of Schröter, they kept sixty on their map, of which some ten had been altered.

In doing this, Beer and Mädler certainly greatly altered for the better Schröter's nomenclature, though it would have been advantageous had they done this in a manner more in accordance with the spirit of Schröter's intentions. But it is too late to make any alteration now; all that can be done is to consider what should be done with the names Beer and Mädler passed over. Mr. Birt and the Rev. T. W. Webb have already restored two of these to the list of lunar nomenclature, and since then three more have been restored in my work on the "Moon," so that this brings the total to some sixty-five. Of the remainder, two or three have been shifted by Mädler to other regions, leaving about half a dozen names omitted. A careful examination of these names, and of the localities to which they were assigned by Schröter, will convince an impartial observer that they had best be left out. As it has been already mentioned "the mere indiscriminate naming of the lunar formations so far from being any gain to selenography, is a positive disadvantage, as rendering the present system unwieldly and un-

manageable" (Astronomical Register of March 6, p. 72). Of course where there is a great gap in the class of named formations, it is a considerable advantage to name some formation after an eminent astronomer or mathematician, and there are many points coming under this description; but Schröter's omitted names, and the formations they are attached to, certainly do not do so. Little advantage would result, therefore, were these being added to the existing nomenclature.

Though, therefore, additions to the already lengthy nomenclature of the moon do not really seem necessary for the progress of selenography, the systematic cataloguing of the principal details upon the moon, and the identification and symbolization of the term may be employed of these details by attaching to them a Greek or Roman letter, would undoubtedly be a distinct advantage. The system devised by Mr. Birt for the British Association map, must, of course, be employed for the purposes of a standard catalogue; but pending that lengthy work being carried out, if all the most important of the minor objects in the moon had a letter, or other symbol, attached to it, so as to permit of its being readily referred to and identified, much would be gained.

REVIEWS.

Results of the Astronomical Observations made at the Royal Observatory, Greenwich, 1873. (Extracted from the Greenwich Observations, 1873.)

This thin quarto of 80 pages cannot fail to be of great interest to astronomers. Great must be the labour, pains, and skill involved in every line of it. Here we have the predictions of the *Nautical Almanac*, founded on the best available tables, tested by careful observations with instruments of first-rate excellence, the accuracy of whose performance is only relied upon after every conceivable precaution has been taken to discover and allow for the imperfections from which even they are not free. But however much one who is only a dilettante in astronomy may admire these 'Results,' there is a class, comparatively very few in number, to whom they will form the material of abtruse and intricate work,—work directed to the perfecting of the theories of the heavenly bodies, and making national ephemerides increasingly accurate. This is work, which, if any other, may be said to "smell of the lamp"; and if few are equal to it, not a great many get so far as to form any adequate idea of what has had to be done before they can enjoy the luxury of a *Nautical Almanac*, a *Connaisance des Temps*, or a *Berliner Jahrbuch*. We have just dipped a little into this book, and proceed to give a slight description of its contents to those who may not have access to it.

We have 1. a catalogue of mean R.A. and N.P.D. for Jan. 1, 1873, of 1033 stars observed in the year 1873, with the transit circle, and their annual variations, also new constants, &c., pp. 1-28.

2. Horizontal and vertical diameters, and R. A. and N. P. D. of the sun,

moon, and planets, deduced from the observations, and compared with the corresponding results of the *Nautical Almanac*; pp. 29-66.

3. Observations of γ Draconis with the Reflex Zenith tube, and reduction of the observations, pp. 67-70.

4. R. A. and N. P. D. of comet I. 1873. (Tempels' comet of short period) and neighbouring stars, observed with the great equatorial. pp. 71-72.

5. Eclipses, occultations, and transits of Jupiter's satellites, compared with the *Nautical Almanac*; and occultations of stars by the moon, with the equations deduced from the occultations. pp. 73-80.

Passing over the important and valuable star-catalogue, we place before our readers a few figures taken from 2, and first, about the SUN. We observe that the apparent error of the *Nautical Almanac* in R.A. ranges from 0·00s to 0·28s. (the latter only occurring once). The app. error of N. A. in N. P. D. ranges from 0″·02 to +5″·94 and — 2″·04 (these only occurring once). On 4 days the app. error in R. A. was 0·00s.; and on 23 days not above ± 0·02s. On 26 days the app. error in N. P. D. was below ±0″·5. The number of days in which these observations were made is 124. 84 days show app. error +, and 36 days —, in R. A. 96 days show app. error +, and 22 days —, in N. P. D. The above mode of noting extreme results of single observations evidently does not place the series in the most favourable light. But if we turn to pp. 57-59, we find the mean errors of the Tabular Geocentric places of the sun and planets for *groups of days*, consisting for the sun, of a month or less; when we see that the mean error in R. A. ranges between —0·013s., and + 0·086s. *i.e.* the limits are confined to hundredths of seconds of time; and in N. P. D. the error never reaches 2 seconds of arc; once was only 0″·18; and in 5 of the 12 groups of days was less than 1 second. So much for our great luminary; thanks to M. Leverrier, the observers, and instrument-makers, to whom we owe this great precision in our solar tables. We go on to the MOON.

Here the app. error of N. A. in R. A. ranges from + 0·12s. to + 0·95s. (this latter only occurs twice). If we have reckoned aright we find a mean of all the days (98) amounts to 0·52s. always +. In N. P. D. the most considerable app. errors are +7″·84, — 8″·38, — 10″·33. On 80 days the app. error did not reach ±5″· and on 12 days it was not as much as 1″. As to signs, the errors are 52 + and 46 —. If we assume an average error of 8″ in R. A. and 5″ in N. P. D. we shall find the error in the moon's position not equal to 9½″, that is the 180th part of her mean app. diameter. If we pick out the most unfavourable day of all, July 18th, when app. errors in R. A. was + 0·94s., and in N. P. D. — 10″·33, we shall find the error in position nearly 17½″, which is the 108th part of the moon's mean diameter. Lastly, if we set off against this the most favourable day, Feb. 12th, errors + 0·14s. and — 0″·28. the error in position comes out 2″·12., which is the 892nd part of the moon's mean diameter. Eminently satisfactory as these results are, we may expect a further improvement on Hansen's tables, when the very arduous work on which the Astronomer Royal is engaged shall have perfected still more the intricate lunar theory. We next briefly take the planets in order.

MERCURY. The app. errors in R. A. range from 0·00s. to + 0·29s, and and in N. P. D. from + 0″·07 to + 2″·86.

VENUS. App. error in R.A. only once as much as +0·31s. and in N.P.D. as much as — 4″·64. But on p. 57, where groups of days are considered, the greatest errors are reduced respectively to + 0·20s. and in N. P. D. to + 1″·42 and —2″·10.

MARS. R. A. + 0·24s. N. P. D. + 4″·91. But on p. 58 these greatest errors become + 0·140s. and + 3″·16.

CERES. Errors as great as—5·22s. R.A., and + 41″·31. N. P. D. This would give nearly 1½′ error of position.

PALLAS. (We pick out always the extreme errors) + 0·66s. and —1″·42.

JUNO.—2·45s. and —1″·78.

VESTA. —1·56s. and +4″·17.

ASTREA. + 7·25s. and — 27″·0. But taking groups of days, these are reduced to + 6·79s. and — 24″·03. Of the other minor planets 54 were observed at Greenwich and Paris. The app. error of *Berliner Jahrbuch* is exceptionally great for the following :—

CLYTIE. (73) + 37s. and — 110″.

AMALTHEA. (113) —43s. and + 88″.

ATE. (111) + 121s. and + 727″.

JUPITER	In R. A.	—0·67s.	In N.P.D.	— 8″·20.
SATURN.	„	—0·99s.	„	— 6″·83.
URANUS.	„	+12·47s.	„	+ 34″·77.
NEPTUNE.	„	+ 0·08s.	„	+ 2″·24.
	„	— 0·22s.	„	— 1″·42.

These are somewhat reduced when a mean is taken of groups of days ; but we may expect much improvement when M. Leverrier's new tables of those great planets are available. There follow an investigation of the position of the Ecliptic, p. 55 : errors of the tabular heliocentric places of the planets, pp. 60-62 ; and then we come to a very interesting table, pp. 63-66. Errors of the moon's tabular place in R. A., N. P. D., longitude, and ecliptic N. P. D. as found both by observations with the transit-circle, and with the altazimuth. For a specimen ; taking the first quarter of the year, in which there are 13 days in which observations with both instruments can be compared, we find as to R. A. that the difference of the results on 7 days was not equal to ± 0·2s. On other 5 days it was under ± 0·4s., and on 1 day it was 0·45s. As to N. P. D. on 6 days, the difference between the instruments was often much under 2″. On 6 other days, often much under 5″, and on 1 day it amounted to 8″·64. Looking to the observations of the whole year, made with the transit-circle, the greatest mean error of the moon's tabular place in longitude is + 15″·27, and in E. N. P. D. + 5″·62 and — 7″·02. With the altazimuth the greatest mean error in longitude is + 16″·48., and in E. N. P. D. + 10″·06, and — 8″·26, and few others at all approach these. Next come observations of γ Draconis above alluded to, pp. 68-70. The greatest concluded mean zenith distance north, 1873, Jan. 1st, is 103″·22, and the least is 96″·44. The observations were made on 48 days, and a mean on all of them, if we have made no mistake in the sum, is 98″·715, and many of the observations of single days are very near this, and seldom approach the above maximum and minimum.

Then follow observations of Comet I., 1873, already mentioned.

Lastly, from the 32 observations of the phenomena of Jupiter's satellites, we select the eclipses, as follows :—

I. Satellite, ecl. disap. app. error of N. A. — 21·5s. — 25·2s. ecl. reap. + 27·7s. + 13·4s. + 10·3s. — 1·7s.

II. Satellite, ecl. disap. — 36·7s. ecl. reap. + 25·1s. + 10.9s.

III. Satellite, ecl. reap. — 21·8s. disap. — 2m. 32·8s.

IV. Satellite, ecl. reap. + 6·9s. — 10·0s.

The other phenomena of transits and occultations, of which only the approximate times are given in the N. A., of course exhibit much more discrepancy.

The ancient Greeks, it will be remembered, had a deity called Momus, whose office it was to find fault with everybody and everything in heaven

and earth. In one of his dialogues Lucian makes this censor blame Hephaistos (Vulcan), because, in the man he formed, a little door had not been put in his breast, so as to disclose his secret thoughts. This son of Night could not have brought a like charge against the work we have been noticing. The door he wanted is always found here. Anyone may note the shortcomings of theory, instruments, and observers, for the errors are arranged and tabulated ready to his hand, and far from shunning, they appear to court the severest criticism. And that we may be sure they have had, and from a very competent source too, before ever they were sent forth in print to meet the eyes of the world of astronomers. In no one spot, probably, will less indulgence be shown them than where they were first detected. Years hence, yet more satisfactory "Results," may, and doubtless will, be issued from our noble establishment at Greenwich: errors now counted by many seconds of arc may become a few tenths, or hundredths of a second, and as even Momus himself could find no blemish in the queen of love and beauty, something approaching to such faultlessness in our tables may be the inheritance of a future generation; though the imperfection of analysis, of instruments, of flesh and blood itself, must leave, however small, a residuum of error or uncertainty. It is related of Jesse Ramsden that having shown a plan of something he wanted to make to a workman, he would often end by saying, "Now, see, man, let us try to find fault with it." And astronomy owes its actual high position to the unceasing efforts of its leading cultivators to reach the highest attainable accuracy; accustomed both in theory and practice freely to find fault with the present in expectation of something better. Under the domain of symbols and calculation above every other science, no comparatively weak point can be concealed, nor, if it were possible, is there any desire to hide it. We trust that in our somewhat rapidly taken survey of the work in question, we may not have made mistakes, or fallen into inaccuracies. It needs no commendation of ours. Even if the next "Results" shall surpass it, and those of every successive year should excel the preceding, each "matre pulchra filia pulchrior"; it will still remain a monument of the state of astronomy in the year 1873, in no slight degree honourable to astronomers of this and of other lands, and not least to the head and his assistants of our national observatory. We would like to watch the countenances of some of the famous old astronomers if it were possible to place before them the figures we have been examining. Men like Hipparchus and Tycho Brahe, Galileo and Bradley must needs sometimes have speculated on the future of astronomy. We question if anything like these "Results" ever entered into the most sanguine day-dreams of the three first-named. The last, indeed, may have had some anticipation of the advance which has been made in a little more than a century after his time. But Bradley, it has been said, "changed the face of astronomy"; and as, according to Bessel, the error of his R. A. observations is generally less than one second of time, and in declination less than 4″; a kind of misty outline of the present proud position of the observatory may peradventure have floated before his eyes. It is not too much to say that his mantle has fallen on one well worthy to wear it; perhaps not too much to suppose, that if the "vir incomparabilis" could now cast his eyes over the columns of these "Results," his face would express of the two more of admiration than surprise.

The Moon and the Condition and Configurations of its Surface. By Edmund Neison, Fellow of the Royal Astronomical Society, &c. Illustrated by maps and plates. London: Longmans, Green & Co. 1876.

(Continued from page 187.)

Chapter IV. is on lunar history from the earliest times to the present. Speaking of Aristarchus, Mr. Neison says, "He was less successful in determining the diameter of the moon, which he fixed at 2°, or more than three times too great." This is doubtful. It is more likely, as Narrien observes, ("Origin and Progress of Astronomy," pp. 207, 208) that great errors have found their way into the text of this ancient author. Archimedes informs us in his *Arenarius*, that Aristarchus made the visible diameter of the sun equal to $\frac{1}{720}$ of the zodiac, or to half a degree, which is very near the truth, and it must have been evident that the visible diameter of the moon is about the same as that of the sun. Or we may adopt the opinion of Laplace ("Précis de l'Histoire de l'Astronomie") founded on the above passage in Archimedes, that Aristarchus subsequently corrected his determination of $\frac{1}{180}$th part of the circumference or 2°.

Galileo constructed by eye-estimates the first lunar map. Numerous drawings were also made by Scheiner and Langrenus, but the first good lunar map was made by Hevelius with a telescope magnifying from 30 to 40 diameters, which remained for over 100 years the best map of the surface of our satellite. Hevelius also discovered the libration in longitude—the libration in latitude had been discovered by Galileo. Four years after the appearance of Hevelius's work, Riccioli, of Bologna, in 1651, published another lunar map, in which he recast the whole lunar nomenclature. He substituted the names of the most distinguished astronomers for the feeble terrestrial analogies of Hevelius, except in the case of the great lunar surfaces already named seas by Hevelius, these Riccioli named after various astrological influences supposed to be exerted by the moon. Riccioli, though an inferior observer to Hevelius, has had the merits of his map much under-estimated, and his labours have afforded results far superior to what would have been expected from the disparaging observations of Beer and Mädler. During the brilliant researches of Newton on the moon's motions, the great astronomer, Dominic Cassini, was engaged in lunar observations, on the basis of which he constructed a lunar chart some twenty inches in diameter, which was published in 1680, but though from his superior optical means this was more complete than Hevelius's, it was inferior in accuracy, the places being only laid down by eye-estimates. To Cassini selenography owed one of its greatest advances, for after twenty-two years' labour he announced in 1693 his theoretical solution of the problem of the lunar optical libration, and discovered a highly interesting relation between the moon's equator and orbit. Cassini's theory stated that if three planes passed through the moon's centre, representing respectively the planes of the lunar orbit, equator, and the ecliptic, all three intersected one another in the same straight line, the line of nodes of the moon's orbit, whilst the third was always situated between the first two. This theory was subsequently completely confirmed by Tobias Mayer, whose design to construct a complete lunar chart was prevented by his early death in 1762. In 1775, however, a small chart only eight inches in diameter, amongst the rest of his inedited works, was published, which remained, until 1824, the only accurate map of the moon, though necessarily wanting in much detail. During the years 1777 to 1779, Herschel made a series of measures for determining the altitude of the lunar mountains,

using four inches aperture, and power 222 on one of his reflectors. It is curious to read Herschel's opinion as to the great probability, if not absolute certainty, of the moon being inhabited.

In 1791 appeared Schröter's "Selenotopographische Fragmente," the first contribution to the study of the details of the moon on an adequate scale, and containing a number of engravings of the appearance of the different formations, with a full description. He commenced his observations with a 4-ft. Newtonian reflector of Herschel's in 1784, and in 1786 he obtained a second instrument from the same maker of 7-ft. focus and about 6-in. aperture, and with these two instruments and powers generally of 134 and 161, the observations in the above work were made. For the observations in the second volume published in 1802, he used among other large instruments, a great reflector by Schräder, of Kiel, of 26-ft. focus and 19-in. aperture. Schröter's instruments, therefore, were of the highest class of the time, and certainly adequate for the purposes for which he employed them, though it is true not comparable for accurate definition with the fine Frauenhofer refractors of later observers. In determining the height of the lunar mountains, Schröter adopted a more satisfactory method than his predecessors, employing the length of the shadows, which when the solar altitude for the given spot is known, enables the height of the object to be deduced with considerable accuracy. He obtained very good results, although generally somewhat over-estimated. But whatever may have been their imperfections, due to deficient measuring apparatus, and to his imperfect realisation of the great optical changes to which lunar objects are liable, for his untiring perseverance, and faithful if roughly drawn sketches, and for his numerous observations, selenography is highly indebted to him, and it is doubtful whether but for his zealous labours, which pointed out the precautions necessary to be taken, Beer and Mädler would have been so successful in carrying out their great work.

From Schröter's time until 1824, the study of the surface of the moon made little progress, but in that year appeared Lohrmann's "Topographie der Sichtbaren Mondoberflache," a first issue of four sections of what was intended when complete to be a detailed lunar map in 25 sections, on a scale of 37½ inches to the moon's diameter. His principal instrument was a 6-ft. achromatic of 4½-in. aperture, by Frauenhofer, fitted with a micrometer and other accessories. Failing eyesight unfortunately compelled him to relinquish all hopes of completing his great undertaking. In 1838, however, he published an excellent lunar map 15¼-in. in diameter, founded on his observations, but on too small a scale to show the lunar details properly. In 1837 appeared the greatest contribution to selenography—Beer and Mädler's "Der Mond," with its accompanying chart, the "Mappa Selenographica," a complete account of the then state of knowledge of the physical condition of the moon, and a full account of topographical details, founded on observations from 1830 to 1837, thus forming the first adequate description and map of our satellite. Mädler, who was the principal observer, made a series of 919 micrometrical measurements, also measured micrometrically the diameters of 148 principal formations, and made a series of 1095 measures of the height of about 830 lunar peaks, whilst by comparing the length of the shadows of less important peaks with a measured peak under similar conditions of illumination, the approximate height of these minor points can be determined with very fair accuracy. Retaining all the names of Riccioli they could identify, as well as nearly all those of Schröter, they added considerably to the lunar nomenclature, by naming nearly 150 new formations, employing principally the names of the later most distinguished astronomers,

mathematicians, geographers, and philosophers, whilst remarkable mountain ranges were named according to the principle of Hevelius, after the chief terrestrial mountain systems. The instrument employed by Beer and Mädler was a Frauenhofer refractor of 3¾-in. aperture, with a power of 300 for drawing and 140 for measuring. As far as optical means are concerned, therefore, B. and M. were using a smaller aperture than Lohrmann, though probably of somewhat superior quality, whilst though in possession of far superior definition than Schröter, his largest telescope gave him considerably greater power over delicate phenomena of little brightness. These differences are of considerable importance in contrasting the results obtained by the three observers. Upon the conclusion of Beer and Mädler's fine work the great questions in connection with the physical condition of the moon were generally regarded as finally solved, with perhaps the exception of some of the obscurer phenomena, which appeared likely to baffle all explanation, such as the great ray or streak systems, and the rills and clefts, but it was generally regarded as demonstrated that the moon was to all intents an airless, waterless, lifeless, unchangeable desert, with its surface broken by vast extinct volcanoes. The attention of astronomers was directed to other fields, and selenography resting on its laurels, made no further progress for many years. Schmidt of Athens alone worked in an adequate manner, though some desultory work was accomplished by Mädler and two or three others.

In 1864, when the imperfect nature of our knowledge of the condition of the moon's surface had been more generally recognised, the British Association appointed a committee with the primary object of devising the best method for the detailed cataloguing and mapping of the lunar surface, and in 1865 the committee in their report described at length the method that had met with their approval, and advised its being carried into effect in the best manner possible. For the purpose of obtaining the requisite material for the completion of a detailed lunar map on the scale of 100 inches to the diameter of the moon, it was determined to construct an outline map of twice this size, so as to allow of the insertion conveniently of all the detail that might be discovered. In 1866, two sections of this map, founded principally on the measures of Beer and Mädler, and on lunar photographs, but containing all known formations, were issued, and embraced the area between 0° to 6° west longitude, and 0° to 10° south latitude, together with a catalogue of the objects inserted. In 1868, a further section 5° square was issued, with a corresponding catalogue, but as after this year the committee was not re-appointed, with the exception of one more section the work has made very slight progress. In their map and catalogue an entirely new system of symbolisation was adopted, affording means of distinguishing every feature of the moon on a systematic plan; and though for general purposes the standard nomenclature of Beer and Mädler will perhaps, from its convenience and ease of remembrance, always be retained, yet for the purpose of the detailed study of separate formations the method employed by the British Association committee will be preferable. The chief defects are the somewhat unwieldly character of the symbols, and the ease of making a mistake in referring, together with the difficulty in remembering the symbols, none, however, of any particular weight.

From the period of the conclusion of Mädler's great work, Schmidt, now of Athens, had devoted much time to observing the lunar surface, and he soon turned his attention mainly to the production of a map that should adequately represent the smaller details of the surface, which he recognised that Mädler's map, from the limited power of the telescope employed, failed satisfactorily to give, though in the main very faithfully drawing

what was shown. For this purpose Schmidt determined that a map 75 inches in diameter would be the smallest adequate size, or four times the size of "Mappa Selenographica," though when completed it is found that the scale selected was still too small for its purpose without more crowding than is desirable. For his map, which was drawn in 1868, Schmidt made a series of over a thousand drawings, and more than three times as many height measures, though it is understood that he made no measures of the position of the principal objects, employing only Lohrmann's and Mädler's, though these are certainly too few for a map of this size.

Since 1868, many observations have been made of lunar formations, but little of importance has resulted, with the exception of a systematic reduction of a number of observations of Plato made during 1869–1871, by a committee appointed in 1870 and 1871 by the British Association, and which contained several highly interesting circumstances indicating some changes of the appearance of objects on this formation not explicable by variation in illumination or in libration. At the end of 1874, the condition of selenography may be considered as having reached one of its resting-points, from which it may start anew on its progress, the results of the previous period of activity having been to mark out distinctly the questions to be determined.

During this period (1864—1874) much of considerable interest has been established, partly by further observations, and partly by comparison of the results and drawings of the earlier observers, and it has been shown that the conclusions arrived at by Mädler require in points much modification. Schmidt and others have pointed out instances of what there exists good reason to consider are cases of physical change in the moon, though only in one instance have these received the attention they merit. Numerous observations have also been made indicating peculiar changes in the visibility and appearance of different formations, not dependent on variations in illumination; many new objects have been detected, now so conspicuous as to appear hardly capable of being overlooked by the earlier selenographers had they then been as distinct; finally, considerable discrepancies have been noticed between the maps of Lohrmann and Mädler in points where peculiar accuracy seems to have been sought for, and apparently very easily obtainable. The result, in short, of the last period of selenographical activity has been to re-open nearly all the questions considered as settled by Beer and Mädler before the true nature of the lunar details were generally understood, and with regard to which the small aperture of their telescopes placed them under a considerable disadvantage.

This survey of lunar history, much abridged and condensed as it is from the fourth chapter, has a certain completeness as far it goes, and will be acceptable to those especially who may be unable to procure this volume. Future chapters on the history of lunar research cannot fail to assign to Mr. Neison's production a high place amongst the classic works on the subject, and if excelled (as of course is to be wished) by subsequent publications, or by itself in improved editions, its value will always remain as a record of selenography in 1876, which may go far to settle in after years the debated questions of the time present.

Those who wish for more than the general information in Chapter I., on the motions, figure, and dimensions of the moon, will find it in Mr. Proctor's work on the moon. We pass on to Chapter II. on the physical condition of the lunar surface. Though the similarity, if not identity, of the material of the earth and of the moon is recognised, yet "in two essential particulars, the lunar surface presents a marked contrast to that of the earth, inasmuch as no water or atmosphere has yet been recognised

for certain as existing upon the moon, though apparently the most marked indications of the action of these agents can everywhere be detected." The disappearance of the lunar oceans, and the great diminution, though as the author maintains, the by no means total absence of the atmosphere, are explained by considerations which seem to have great weight. He concludes that the density of the moon's atmosphere would not much exceed one three-hundredth of the earth's, that such an atmosphere is possible on the moon, and that "had the correct value been obtained at first, the conclusions which have been arrived at by various selenographers, and especially by Mädler, would have been materially altered." To detect the attenuated residue of atmosphere, the observed times of lunar occultations, compared with the predicted, offer the most reliable and delicate test. Now, the results of a very great number of these observations, both at Cambridge and Greenwich, during a period of above 40 years, show that "between the value of the moon's occultation and its measured semi-diameter there exists a difference of some magnitude, corresponding to a retardation of occultation of usually from five to ten seconds of time, and not apparently to be explained by the effects of irradiation. Consequently the existence of a lunar atmosphere of sufficient density to produce the difference found, is without doubt possible, and moreover, considering the consistent nature of the results obtained from the observations and the apparent inadequacy of their being explained by other causes, the actual existence of such an atmosphere is rendered probable." The maximum amount of horizontal refraction at the limb thus determined, the most probable density of the atmosphere may be assumed as about one three-hundredth of that of the earth, but owing to the uncertainty (within very small limits) of the real value of the moon's semi-diameter, this must be regarded merely as its probable density. A more certain conclusion may perhaps be obtained from further observations. Mr. Neison points out that this atmosphere is not "incapable of exerting as powerful influences on the surface as the earth's; for the slow decrease in its density, and its proportionate much greater volume, counterbalances its small surface density, consequently its mass in proportion to that of its planet is only a little less than a fourth of that of the earth's, and with regard to even a single square mile in area of the surface must be estimated by millions of tons. The importance of an agent of this nature in connection with the present condition of the moon, and with reference to its past history is apparent, as affording an adequate explanation of some of the most interesting but otherwise inexplicable appearances presented by our satellite." As may be expected the *direct* evidence of an atmosphere of such very slight density is still uncertain. Nevertheless, some of Schröter's observations made with his great telescope, which he held to be proof positive of an atmosphere, still remain unexplained. Such is twilight at the cusps of the moon, confirmed by Gruithuisen and others—the dim and obscure appearance of certain localities whilst all around were sharp and clear—a blue transient fringe to crater walls at sunrise, quickly disappearing and entirely local, seen by Beer and Mädler and Schmidt—a grey border to the black shade of the deep crater formations, seen by Schröter and Schmidt—a misty appearance at sunrise, detected within deep formations, blotting out details for a time and disappearing as the sun rose. A broad penumbral fringe of light shadow has also been observed, bordering the real shadow, and vanishing soon after sunrise. These delicate appearances are only to be detected by powerful instruments, and by those to whom the region in question is thoroughly familiar, and as yet their evidence cannot be considered decisive. Observing that the primitive lunar oceans may probably

have disappeared, owing to the strong absorbing power of the lunar surface, in the same manner as the earth's have been materially diminished, Mr. Neison says it is probable that a very small residuum of aqueous vapour may exist at times and in places, and as the last traces of the lunar seas must have lingered in the interior of deep formations, a temporary vaporous covering might then be liberated by the solar heat, to be slowly re-absorbed by the cooling of the surface. Some otherwise inexplicable appearances may thus be explained.

Alternately heated to a great degree by the sun's rays, and cooled by radiation into space, the variation in temperature of the moon's surface must be considerable. Lord Rosse has lately determined with some precision variations of the relative amounts of heat transmitted by the moon to the earth,* though the actual temperature of the lunar surface is still unknown. Mr. Neison observes that the presence of even an extremely rare atmosphere must greatly temper both the heat and cold, the former especially in high latitudes, and the latter by retarding radiation during the long lunar night. "From its very much greater comparative extent, a lunar atmosphere would retard the lowering of the surface by radiation as completely as one a hundred times as dense on the earth. . . . . . Considering that the probable atmosphere would in its effects be not much if at all inferior to the earth's, together with the circumstance that in the terrestrial long arctic night, much exceeding in length the lunar, the radiation is not sufficient to produce more than a moderately low fall of temperature, it would seem unnecessary to suppose any considerable fall could occur upon the moon, and this is confirmed by the known condition of the variation in the amount of heat radiated by the lunar surface." From Lord Rosse's observations it would appear that the maximum surface temperature of the moon cannot exceed 200° C., whilst it is probably less, and that the minimum temperature cannot be much under zero centigrade, to allow of the agreement observed between the variation of light and heat during each lunation. "At present Lord Rosse regards his results as not affording any trustworthy means of determining the lunar temperature with any exactitude, and they do not appear sufficiently developed to do more than aid in results afforded by theoretical considerations."

Galileo compared the circular districts in the moon with the great closed basin of Bohemia. Gassendi has been said to remind one vividly of the volcanic region of Auvergne, and Maurolycus with its *cortége* of craters of all sizes, to present a striking analogy with the volcanic system of Vesuvius. But the impression received by the following bird's-eye view of the lunar hemisphere is not one of resemblance to the terrestrial surface: "Neither oceans, seas, nor river systems, into the accompanying formations, but a desert containing innumerable craters and surface irregularities. All over the lunar surface, crowded especially into the south-west quadrant, appear circular deep depressions, ringed round by regular walls, and presenting the appearance of craters, evidence seemingly of the results of vast volcanic convulsions, whilst the remainder of the surface consists of comparatively level spaces, usually dark in colour, separated more or less from each other by mountainous regions, full of considerable peaks, which are united by smaller masses and long ridges, while in every direction are dispersed numbers of small craters of

* It was for ages thought that the lunar rays were frigorific, and the Sanscrit name for the moon, *himansu*—having cold rays—indicates the same erroneous opinion, which ascribed to the moon the effects of free radiation on a clear night. The same appears in the pretty myth which made Hersé (dew) daughter of Zeus (sky) and Seléna (moon).

different sizes and depths." Closer examination, however, with powerful instrumental means reveals far more of terrestrial analogy in the structures of the moon. The great craters are seen more in their true character, not as craters but as low-lying spaces surrounded by mountain regions, or disturbed highlands. Similarly the *ring-plains* are manifestly not volcanoes in the ordinary acceptation of the term, but rather depressions surrounded by mountain ranges, and it is very doubtful whether the great number of apparently small craters really are such, and not rather shallow hollows such as are not uncommon in the earth. True craters are much rarer than is usually considered. "In most disturbed districts they can be recognised rising steeply from the surface, with a precipitously falling conical aperture of small dimensions, whilst all around lies apparently ejected matter, visible often in long streaks radiating in various directions to the lower lying districts These formations when perfect are usually readily distinguished by their brightness." The great craters have often smaller crater-cones on their steep slopes.

The difficulty of thoroughly realising the points of resemblance between the terrestrial and lunar formations, owing to the very different conditions under which they are seen, is thus described: "The details of the lunar surface being only visible when thrown into relief by shadow, the whole is never to be seen at the same time, but the various irregularities and conformations of the surface have, as it were, to be pieced together into one united whole. Long gentle slopes, even if of considerable altitude, such as form the majority of the river valleys of our earth, are on the moon scarcely perceptible, even with the most careful examination, and every little irregularity breaks the continuity, and gives them a very different appearance to that which they would exhibit when viewed from a level; but under very favourable conditions regular systems of these valleys can be traced. The terrestrial formations generally regarded as absent from the lunar surface are usually of small dimensions, and marked by no striking characteristics, such as would be necessary to reveal their existence when seen on the moon, where, moreover, they would reasonably be supposed to be much less marked than on the earth: they would thus be objects whose detection would not be easy. But this recognition would be still more difficult from their being seen only in small portions at a time, and their real characters masked by the throwing into relief of every subordinate irregularity by the action of its shadow, so that the more important and extensive, though less abrupt features are entirely disguised. Before, therefore, anything can be decided with respect to such comparatively delicate, even if extensive, features as lunar river systems, diluvial deposits and gentle slopes, the endeavour must be made by systematic study of the minuter details of the moon to piece them together, until the real conformation of the surface that they are the indications of has been ascertained. At present very little progress has been made in this direction, and no legitimate conclusion can be arrived at with respect to the absence of any terrestrial features, much less with respect to the non-existence of the cause to which such formations must be considered due."

"A considerable number of examples of the class of formations usually supposed to be absent from the moon, such as valleys resembling the terrestrial river valleys, have of late been discovered, especially in the region near Hell, Fabricius, and the great Apennine highlands, and usually in connection with the more delicate class of rills . . . . On approaching the dark grey Mares, however, these valleys gradually sink and disappear, obeying a very generally observed tendency in this direction, which is as marked in the mountains and walled plains as in

the valleys and hills. There are many indications, in fact, of the presence on the Mares of some especially powerful disintegrative agent; [Might we not include tidal action at a remote period?] whilst, as already remarked by Chacornac and confirmed by most observers, the surface of the great grey Mares appears to have been fluid long after the principal formations of the moon had become permanently rigid. This is especially to be noticed in those cases in which the presence of some powerful disintegrative force seems to have broken down into ruins the wall bordering the Mare, whilst that abutting on the higher land remains intact, and the interior appears to have been filled up by the inrush of fluid material from off the Mare itself. In many other cases also, on the borders of the Mares, there are very strong and consistent indications of the originally semi-fluid condition of the Mares, in the form of filled up ring-plains, submerged mountains, and walled plains, eruption of matter into valleys, &c.; and there are also indications of the gradual solidification of the Mare in the shape of less and less plasticity in the intruding matter." "These circumstances are particularly interesting in connection with the view as to the probable cause of the disappearance of water from the moon, as they are exactly in accordance with what would be expected to arise. For as the action of the surface removed the water from them, the Mares would gradually be reduced to the consistency of mud; and while their presence accounts for the greater disintegration observed towards the borders of the Mares, the semi-fluid condition of the surface would account for the irruption of plastic material into the formations, whenever gaps in their walls permitted this to occur." With the closing sentence of this chapter we fancy those who have given most attention to the subject will entirely agree:—"The gradual progress in our knowledge of the present condition of the surface of our satellite is surely, if slowly, pointing out, in unmistakable terms, the entire analogy in nature, if not wholly in degree, of the forces that have moulded the surfaces of the earth and moon to their present state."

The question is often asked, what is the smallest object that can be made out in the moon? To this a short and definite answer can hardly be given. At best we only see it at a distance of many hundreds of miles. The shadow of the Great Pyramid, according to Mädler, would be scarcely one-ninth of a second in breadth, even at its widest part, and would, therefore, remain invisible. The following passage, however, furnishes the best reply to the inquiry:—"It is true, as Mädler remarks, that a steep object, only fifty feet high, could be detected by its shadow, but only, however, when of considerable length and very favourably placed in an open region, as on a level portion of one of the great *Mares*; and under other conditions it would usually be quite invisible if two or three times as high, whilst in one of the more disturbed regions it would be scarcely detected if ten times as elevated. As a general rule, formations of a mile in length and a height of three hundred feet are the minimum visible in even powerful telescopes, though in places at times smaller objects may be rendered visible under favourable conditions; whilst in a great portion of the moon, objects of much more considerable dimensions, especially when with gentle slopes, are rarely to be seen.

(To be concluded in our next.)

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.
To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

TWILIGHT.

Sir,—Two years ago when I made some naked eye observations on Coggia's Comet (see *Register* for 1874, p. 220), I was somewhat puzzled by what seemed the excessive amount of twilight for the time of year. The almanacs all state that in latitude of Greenwich there is "real night" after July 21st, which was the last night on which the comet was visible here.

As the difference in latitude (55 min. 42 sec.) between Greenwich and my house did not appear to be sufficient to account for it, I proposed to have made some observations on the duration of twilight last year, but moonlight prevented it—this year, however, absence of moonlight and settled weather has enabled me to attend to it, as follows:—

July 20th, 1876, 12h. 12m. G.M.T. Atmosphere extremely transparent, a strong clear twilight—5 mag. stars (26 and 27 Lyncis), visible in N. nearly to the horizon. Sun's centre below horizon 17° 8′ (neglecting refraction).

July 24th, 12h. 12m. Sun below horizon 17° 56′; sky tolerably clear, but atmosphere not very transparent. A decided twilight, but not so strong as on the 20th.

July 25th, 12h. 12m. Sun below horizon 18° 10′; barometer 29.80 (280ft. above sea level). Twilight similar to last night, a few horizontal streaks of cloud shewed sharply against the light; 21 and 22 Lyncis visible.

July 29th, 12h. 12m. Sun below horizon 19° 5′; barometer 29.70; atmosphere extremely clear and transparent. A very decided twilight, some elms stood out sharp and black against the light. 35 and 22 Lyncis visible.

July 31st, 12h. 12m. Sun below horizon 19° 35′; barometer 29.52; atmosphere wonderfully transparent; a decided twilight in N. horizon, but small in amount. 31 Lyncis visible.

After the 31st observations were stopped by the moonlight.

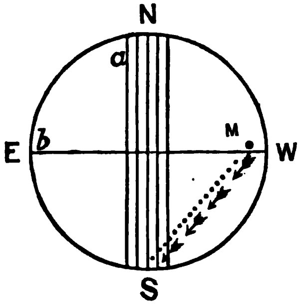
It will thus be seen that the statement in most astronomical works that there is "real night" when the sun is more than 18° below the horizon, is not strictly correct.

Yours truly,
WILLIAM ANDREWS.

Gosford Green, Coventry.
Lat. 52° 24′ 20″ N.
Long 1° 29′ 40″ W.

METEOR.

Dear Sir,—On the 16th of this month while taking a transit observation on Venus, and whilst watching for the *ingress* of the planet in the field of my small alt-azimuth, by Jones, I observed a brilliant meteor passing through the field of the telescope, which the enclosed diagram will best explain The meteor presented itself as a perfectly round disc,



brilliantly white and of the size of a star of first-rate magnitude. Its descent lasted about two or three seconds ere I lost sight of it in the field of view, and the time of my regulator, when at once I looked round, showed 21 minutes before 12 o'clock, mean Greenwich time. I wish also to mention that instead of a diagonal eye-piece I have adapted the prism of the camera lucida from my microscope to the eye-piece of my transit instrument, and which acts most excellently.

I remain, dear sir,
Yours very respectfully,
F. M. D'ALQUEN.

8, Montpellier Terrace,
Brighton:
27th July, 1876.

P.S.—I wish, with your kind permission, to supplement a few remarks concerning my employment of a camera lucida instead of my diagonal eye-piece. The ordinary eye-piece of my transit instrument has a small projecting brass rim, to which I adapted the camera lucida. The advantage I derive from this arrangement I find is, firstly—that I get a more perfect image of the object under observation: secondly—that when I get stars of lower altitudes I have merely to remove the camera, and use direct vision, thus obviating, as I sit before the instrument, any change of position, and so particularly avoiding the very objectionable stooping down one, and thirdly—having not to alter the focus of the telescope.

As any little practical hint, which may add to the better observation and comfort of the observer, may be of service to other amateurs in possession of small transit instruments like myself, I felt induced to write these few lines for insertion, if you should consider them worthy enough.

AUGUST METEORS.

Dear Sir,—Last night I saw sixty meteors during a watch extending from 9 to 12.

A large number had trains, and though the quantity was smaller than sometimes, the quality was very good. About 11.24 a very fine one appeared about 6° north, preceding α Coronæ Borealis, passing between that star and ϵ Boötis, and died out a few degrees S.W. of α Coronæ.

It was much brighter than Venus, appearing as a broad pale green flash, leaving an orange train for fully a minute, so I had time to note its position fairly well. If anyone wishes for a map of it, to compare with other observations, which will most probably be forthcoming, I shall be very glad to send it. About twenty out of the sixty were obviously not "Perseids," some radiating from Cygnus.

Yours truly,
H. CORDER.

Writtle, near Chelmsford:
August 12th, 1876.

HALOS, &c. IN 1875.

	Halos. Solar.	Lunar.	Thunder or Lightning.	Zodiacal Light.
January	3	—	1	1
February	3	—	1	1
March	3	1	—	3
April	4	—	1	—
May	1	1	1	—
June	2	—	5	—
July	4	—	2	—
August	—	—	3	—
September	4	—	5	—
October	2	—	—	—
November	1	1	1	—
December	1	—	—	—
	28	3	20	5

Mr. Edward Crossley's Observatory,
Bermerside, Halifax: J. GLEDHILL.
August 9th, 1876.

TABLEAU OF ASTRONOMICAL CLIMATES OF VENUS.

Dear Sir,—The perusal of M. Guillemin's *Le Ciel*, far inferior in solid value to Mädler's *Popul. Astron.*, Berlin, 1841, induced me to form the annexed Tab. of sun's meridian altitude at various geograph. latitudes of Venus, supposing the equator inclined at seventy deg. (not $23\frac{1}{2}$ as with us) to her orbit, and referring the quarter year of $57\frac{1}{2}$ of her days to our year of $91\frac{1}{4}$ of our days, so as to familiarize us with the diurnal change of her climates. Formula sin. decl. = sin. long. ($\frac{360}{230} = 1^\circ\ 33\frac{21}{23}'$ p. day) $\times$ sin. 70° (log. 9·9729858). I assume one Venus' day $= \frac{8}{5}$ of our calendar ones. Alts. below bar — are our "sub polo." When sun's decl. s. exceeds co-lat. N. he will not rise in N. lat., therefore invisible for interval indicated in tab. under each lat. Sun repasses zenith on the days indicated in tab. Climates seem to resemble that of St. Petersburg, Norway, &c., except near equator. This assimilation to our vulgar percentage of northern half-year, will more strikingly exhibit the climates, the hybernating habits of the fauna, peculiar flora, &c., as I am strongly possessed with the idea that our earth contains *living and generating* specimens of organisations under every variety of habitable data, and the farther planets may have beings like our deep water fish, our moles, our proteus of the Adelsberg caves in their corporeal adaptations. For 70°, 72° or 75° give climates more variable. Further, I noticed thirty years ago that our recent binary star astronomy is a primitive feature of the astronomy of Venus or Mars: for the greatest elongation angle of our moon from our earth is to them

$$\frac{240000}{(94 \pm 68)\ 10^6} \text{ and } \frac{240000}{(143 \pm 94)\ 10^6} \text{ i.e. } \frac{3438'}{675} \text{ to } \frac{3438'}{110} \text{ or } 5' \text{ to } 31' \text{ for}$$

Venus and $\frac{3438'}{982}$ to $\frac{3438'}{204}$ or $3\frac{1}{2}'$ and $17'$ for Mars, which elongation reduce to zero in $7\frac{1}{4}$ of either planet's day, and this possibly was the ground of an archaic calendar, such as terrestrials possess in the luni-solar periods: thus 99 times 29·53 days equals 8 × $365\frac{1}{4}$ or 13 × 224·9 serves for fundamental Venus calendar. Guillemin makes express train

from earth reach sun in 337½ years, *i.e.*, Copernicus's Book, 1543, arrives 1880, six years after transit of Venus. "Pas aux Dames."

June 29, 1876: **Yours faithfully,**

23, Upper Barnsbury Street, N. **S. M. DRACH.**

Day for Eqnx	Terr. N. Cal.	Long. orbit.	Dec. Alt. P.M.	Alt. at lat. Geogr. Venus. 80° L.	70° L.	60° L.	50° L.	40° L.	30° L.	20° L.	10° L.	0°
	d. dec.	° ′	°	°	°	°	°	°	°	°	°	°
0	Mh. 21 0	0·00	0·00	10·00	20·00	30·00	40·00	50·00	60·00	70·00	80·00	90·00
1	22 6	1·68	1·28	11·28	21·28	31·28	41·28	51·28	61·28	71·28	81·28	88·32
3	25 8	4·42	4·25	14·25	24·25	34·25	44·25	54·25	64·25	74·25	84·25	85·35
5	Mh. 30 0	7·50	7·20	17·20	27·20	37·20	47·20	57·20	67·20	77·20	87·20	82·40
7	Ap. 2 2	10·58	10·18	20·18	30·18	40·18	50·18	60·18	70·18	80·18	89·42	79·42
9	5 4	14·06	13·14	23·14	33·14	43·14	53·14	63·14	73·14	83·14	86·46	76·46
11	Ap. 8 6	17·14	16·10	26·10	36·10	46·10	56·10	66·10	76·10	86·10	83·50	73·50
13	11 8	20·22	19·05	29·05	39·05	49·05	59·05	69·05	79·05	89·05	80·55	70·55
15	15 0	23·30	22·00	32·00	42·00	52·00	62·00	72·00	82·00	88·00	78·00	68·00
17	18 2	26·37	24·54	34·54	44·54	54·54	64·54	74·54	84·54	85·06	75·06	65·06
19	21 4	29·45	27·48	37·48	47·48	57·48	67·48	77·48	87·48	82·12	72·12	62·12
21	24 6	32·54	30·41	40·41	50·41	60·41	70·41	80·41	89·19	79·19	69·19	59·19
23	Ap. 27 8	36·02	33·33	43·33	53·33	63·33	74·33	84·33	85·27	75·27	65·27	55·27
25	May 1 0	39·10	36·24	46·24	56·24	60·24	76·24	86·24	83·36	73·36	63·36	53·36
27	4 2	42·17	39·12	49·12	59·12	69·12	79·12	89·12	80·48	70·48	60·48	50·48
29	7 4	45·25	42·01	52·01	62·01	72·01	82·01	87·59	77·59	67·59	57·59	47·59
31	My. 10 6	48·33	45·41	55·41	65·41	75·41	85·41	84·19	74·19	64·19	54·19	44·19
33	13 8	51·41	47·30	57·30	67·30	77·30	87·30	82·30	72·30	62·30	52·30	42·30
35	17 0	54·49	50·10	60·10	70·10	80·10	89·50	79·50	69·50	59·50	49·50	39·50
37	20 2	57·57	52·48	62·48	72·48	82·48	87·12	77·12	67·12	57·12	47·12	37·12
39	23 4	61·04	55·20	65·20	75·20	85·20	84·40	74·40	64·40	54·40	44·40	34·40
41	26 6	64·12	57·47	67·47	77·47	87·47	82·13	72·13	62·13	52·13	42·13	32·13
43	My. 29 8	67·14	60·07	70·07	80·07	89·53	79·53	69·53	59·53	49·53	39·53	29·53
45	Ju. 2 0	70·26	62·18	72·18	82·18	87·42	77·42	67·42	57·42	47·42	39·42	27·42
47	5 2	73·34	64·20	74·20	84·20	85·40	75·40	65·40	55·40	45·40	35·40	25·40
49	8 4	76·42	66·08	76·08	86·08	83·52	73·52	63·52	53·52	43·52	33·52	23·52
51	Ju. 11 6	79·50	67·20	77·20	87·20	82·40	72·40	62·40	52·40	42·40	32·40	22·40
53	14 8	82·58	68·51	78·51	88·51	81·09	71·09	61·09	51·09	41·09	31·09	21·09
55	18 0	86·06	69·38	79·38	89·38	80·22	70·22	60·22	50·22	40·22	30·22	20·22
57	21 2	89·14	69·59	79·59	89·54	80·01	70·01	60·01	50·01	40·01	30·01	20·01
59	Ju. 24 4	92·22	69·51	79·51	89·51	80·09	70·09	60·09	50·09	40·09	30·09	20·09
Sun	invisible	from to	22 Sp. 21 Mh.	3 Oct. 10 Mh.	13 Oct. 28 Fb.	25 Oc. 16 Fb.	7 No. 4 Fb.	17 No. 14 Ja.	30 No. 11 Ja.	Dc. 22	always visible	by day.
Sun	in zen. N.	hemis.			Ju. 22	Jy. 16	Jy. 28	Ag. 7	Ag. 16	Ag. 27	Sp. 9	Sp. 22.

THE MOON.

Sir,—In your review of my work on the moon in the last number of the *Astronomical Register*, it stated that no information is given with regard to the power with which the different tinted drawings of the various lunar formations were made. Reference to the right hand corner of each drawing will show, however, the power employed, which was 330 for the drawing of sunrise on Agrippa, 450 for the same under meridional illumination, the same for Plato near sunrise, and 530 for Copernicus, and 600 for Plato near full moon.

I should not have referred to the above point had it not been that I should like to draw the attention of lunar observers to the question of the best powers for lunar observation, and in particular to the study of the aspect of lunar formations under meridional illumination. For ordinary observation of the surface of the moon when under oblique illumination, eye-pieces of a magnifying power of from 45 to 35 to the inch, according as the aperture varies between 4 to 10 inches, will in general be the best. This is a circumstance I believe generally familiar to all observers of our satellite, for a little experience soon shows that higher powers render the detection of minute dark shadows and other features a task of considerable difficulty. When a region is thoroughly familiar, and the definition of the highest excellence, somewhat higher powers can be occasionally used with advantage, but it will, I think, be rarely found that with aperture of from 8 to 10 inches a higher power than 450 can be used with advantage. Smaller telescopes will permit proportionately higher powers in accordance with a well understood fact.

What however is, I believe, not so well known a circumstance is that when observing a lunar formation under high illumination, as high a power as the state of the atmosphere will permit will often prove in the highest degree serviceable. If the definition of the telescope is of sufficient excellence, and the state of the atmosphere does not prohibit its use, for the study of a region of the moon under high illumination, a power of from 70 to 80 to the inch will generally be found the best that can be employed. Under these circumstances it is surprising the great amount of lunar detail which can be made out; details which under oblique illumination are hidden in the deep shadows, can often be detailed with facility. On the other hand, a moderate power, such as would be most advantageous under ordinary circumstances, will usually fail to show any detail whatever. The rationality of this is obvious, the high power not only by diminishing the total amount of light, but also in increasing the apparent dimensions of the various delicate gradations of shade which mark the different angles of slope of the various formations, enables them to be seen with ease.

Under these conditions, with 9½-inch aperture and a power of about 750, the entire rill systems in connection with the great rills of Ariadæus and Hyginus can be seen as two delicate irregular white lines due to the rugged slopes of the rills, enclosing a delicate greyish line, the floor of the rills. The principal members of the rill systems of Triesnecker and Ramsden can also be seen at Full, generally as thin white lines, and occasionally these two lines can be seen divided by the extremely delicate darker line from the floor of the rill. In Full, the great brightened plateaux of the Apennines and Caucasus exhibit innumerable gradations of delicate greyish white, and enable these most difficult regions to be better mapped than at any other period.

Whilst writing on this subject I may take the opportunity of explaining that in the work I have systematically followed Mädler's nomenclature

throughout, as far as possible, and this will account for the spelling of the names Buco, Ptolemäus, Hekatäus, Frauenhofer, Almanon, and others mentioned in your formidable list of errata. Whether the strict adherence to the nomenclature of Beer and Mädler that has been practised in the work is advisable or not may be open to question, but it appeared to offer so many advantages that it was adopted.

I would also beg to rectify an omission in the historical portion of the work, for though the labours of the British Association Committee is repeatedly and at some length referred to, although not more so than the results achieved would warrant, and though in other portions of the work it is implicitly implied that the work was mainly the result of the labours of our well known selenographer Mr. W. R. Birt, I find that this fact is not explicitly stated where it ought to have been stated. That to Mr. Birt is to be ascribed the main results obtained by the British Association is a fact, I suppose, well known to all astronomers, it is, however, a mere matter of justice that I should here rectify the accidental omission on my part. E. NEISON.

WEATHER REPORT.

In accordance with the personal request of the Editor of the *Register*, I have since that time kept notes of the weather at this point for astronomical purposes, and herewith give the results, covering a period of forty-one nights, from June 21st to July 31st inclusive:—

First-class nights	11
Clear and generally moderately good ...	17

By first-class is meant such nights as are suitable for the observation and discovery of double stars under $0''\cdot5$ in distance with a 6-inch aperture. It should be added that the exhibit is a remarkably favorable one for this place. I doubt if the six months embracing the latter part of last year and the commencement of this furnished as much time for doing difficult telescopic work.

Chicago: August 2nd, 1876. S. W. BURNHAM.

NEW PLANET (164).

From the *Bulletin International*, No. 195.

New Planet (164), discovered by M. Paul Henry, at the Observatory of Paris.

Paris M. T.	R. A.	Dec.
1876. July 12.	11h. om.	— 21° 59′

Daily motion = — 37s — 7′. Mag. 12·5.

LUNAR OBJECTS SUITABLE FOR OBSERVATION IN SEPTEMBER, 1876.

By W. R. Birt, F.R.A.S., F.M.S.

Mr. Neison finishes the preface of his most important work on the moon as follows:—"In conclusion, the author would be obliged by all corrections or extensions the text or maps may require being communicated to him as soon as they are detected during further selenographical observations." The want of sufficient time and the pressure of other avocations prevents me communicating to him personally a notice of a formation which I have not found on Beer and Mädler's map, nor is it on

Mr. Neison's improved map; to find it on the moon the observer must bring into the field the fine group of Theophilus Cyrillus and Catharina shortly after sunrise upon it, and in the bend or saddle, formed by the continuous western walls of Cyrillus and Catharina, he will see two bright walls projecting from the boundary of the two large walled plains meeting at an angle and *enclosing* a space. This formation is certainly absent from Mr. Neison's map XXI. It was observed and sketched in 1864, October 5, and registered under the symbols IV. B π 3, and IV. B λ 13. It was further observed on October 7, 1864, when it was remarked that the western wall composed of south-west and north-west portions including the angle was much more developed than the eastern; a bright crater IV. B π 5 was seen on the south-west wall. The north-west wall from the crater IV. B π 5 to its north point was *highest*. The eastern wall, which is part of the western boundary of Cyrillus and Catharina, is very much lower than the western, nor is there any appearance of angular points in it. The three walls, the eastern, south-western, and north-western enclose a floor brighter than the immediate neighbourhood, but inferior to the small crater IV. B π 5.

1876, August 8, 10.30 to 11.30. G. M. T.—The small crater IV. B π 5 was estimated to have 6° of brightness. The formation IV. B π 3; IV. B λ 13 was well seen, and a small crater IV. B π '20 also on the south-west wall and very near Cyrillus and Catharina was registered as of 6°·5 of brightness.

THE PLANETS FOR SEPTEMBER.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	12 4 6	S. 0 55	5″·6	1 19·9
	9th	12 42 24	S. 6 15	6″·0	1 26·7
	17th	13 14 41	S. 10 44	6″·8	1 27·4
	25th	13 37 21	S. 13 49	7″·8	1 18·5
Venus ...	1st	7 49 27	N. 16 55	31″·6	21 2·0
	9th	8 16 26	N. 16 29	27″·6	20 57·5
	17th	8 46 17	N. 15 35	25″·0	20 55·8
	25th	9 18 0	N. 14 11½	23″·0	20 56·0
Jupiter ...	1st	15 31 8	S. 18 20	33″·6	4 46·4
	9th	15 35 22	S. 18 36½	33″·8	4 19·2
Saturn ...	1st	22 27 29	S. 11 40½	17″·2	11 41·6
	9th	22 25 15	S. 11 53½	17″·0	11 7·9
	17th	22 23 7	S. 12 3	17″·0	10 34·3
	25th	22 21 11	S. 12 16½	17″·0	10 0·9
Neptune ...	9th	2 13 27	N. 11 30	...	14 55·5
	25th	2 12 14	N. 11 23	...	13 51·4

Mercury sets half an hour after the sun at the beginning of the month, the interval decreasing.

Venus may be observed for about an hour and a half before sunrise.

Jupiter sets on the 1st about an hour after the sun, the interval decreasing.

Saturn may be seen throughout the night till about 4·30, after midnight on the 1st, the interval decreasing.

ASTRONOMICAL OCCURRENCES FOR SEPTEMBER, 1876.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Saturn.
Fri	1		Sidereal Time at Mean Noon, 10h. 43m. 57·87s.			11 41·6
Sat	2	10 43 11 57 19	Occultation of 45 Aquarii (6) Reappearance of ditto Conjunction of Moon and Saturn 0° 29′ S.	3rd Oc. R. 2nd Sh. I. 2nd Tr. E.	8 21 8 38 8 44	11 37·4
Sun	3	9 13 11 31	○ Full Moon Near approach of h^1 Aquarii (5½) Eclipse of the Moon, visible at Greenwich	1st. Sh. E.	7 17	11 33·2
Mon	4		Sun's Meridian Passage 0m. 36·63s. before Mean Noon			11 29·0
Tues	5					11 24·8
Wed	6					11 20·6
Thur	7					11 16·3
Fri	8	8 7	Occultation reappearance of 47 Arietis (6)			11 12·1
Sat	9			1st Oc. D.	8 52	11 7·9
Sun	10	16 20	☾ Moon's Last Quarter	1st Sh. I. 1st Tr. E.	6 59 8 2	11 3·7
Mon	11			1st Ec. R.	6 22 32	10 59·5
Tues	12		Saturn's Ring: Major axis=42″·72 Minor axis=6″·22			10 55·3
Wed	13	21	Conjunction of Moon and Venus 6° 43′ S.	3rd Sh. E.	7 11	10 51·1
Thur	14					10 46·9
Fri	15		Illuminated portion of disc of Venus=0·459 Illuminated portion of disc of Mars=0·997			10 42·7
Sat	16	13	Conjunction of Moon and Mars 0° 31′ N.			10 38·5

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage
		h. m.			h. m. s.	h. m. Saturn.
Sun	17	9 54	● New Moon Eclipse of the Sun, invisible at Greenwich	1st Tr. I.	7 47	— 10 34·3
Mon	18		Sidereal Time at Mean Noon, 11h. 50m. 59·29s.	2nd Oc. D.	6 21	10 30·2
Tues	19	11	Conjunction of Moon and Mercury 0° 2′ N.			10 26·0
Wed	20		Sun's Meridian Passage 6m. 48·33s. before Mean Noon	3rd Tr. E.	6 49	10 21·8
Thur	21					10 17·6
Fri	22	6 36 6	Near approach of *b* Scorpii (5) Conjunction of Moon and Jupiter 5° 43′ N.			10 13·5
Sat	23	5 56 7 17	Occultation of B.A.C. 5603 (6½) Reappearance of ditto			10 9·3
Sun	24					10 5·1
Mon	25	0 3	☽ Moon's First Quarter	1st Oc. D.	6 58	10 0·9
Tues	26			1st Tr. E. 1st Sh. E.	6 30 7 32	9 56·8
Wed	27					9 52·7
Thur	28	6 41 7 54	Occultation of 27 Capricornis (6) Reappearance of ditto			9 48·5
Fri	29	23	Conjunction of Moon and Saturn 0° 18′ S.			9 44·4
Sat	30					9 40·2
OCT. *Sun*	1	7 30 8 2	Occultation of B.A.C. 8184 (5½) Reappearance of ditto			9 36·1

SATELLITES OF SATURN.

Approximate Greenwich sidereal times of conjunctions and elongations occurring between 16h. and 6h. Greenwich sidereal time.

f. conj. with following edge of ring.	n. north of ring.
p. " " preceding " "	s. south "
sup. superior conj. with centre of ball.	e. at greatest eastern elongation.
inf. inferior " "	w. " western "

1876.	Gr. Sid. Time. h		
Sept. 1	18·0	Encel.	e.
	22·6	Tethys.	sp.
	23·1	Encel.	sf.
	23·1	Mimas.	e.
	1·3	Dione.	sf.
	1·4	Rhea.	e.
	5·5	Encel.	sp.
2	16·6	Titan.	inf. 27″ s.
	21·3	Tethys.	nf.
	21·7	Dione.	w.
	21·8	Mimas.	e.
	22·0	Encel.	nf.
	0·0	Rhea.	sf.
	3·0	Encel.	e.
	4·6	Rhea.	inf. s.
	5·2	Tethys.	e.
	Moon near.		
3	18·0	Dione.	nf.
	19·5	Encel.	w.
	20·0	Tethys.	sp.
	20·5	Mimas.	e.
	0·5	Encel.	np.
	3·9	Tethys.	w.
4	17·0	Encel.	sf.
	18·7	Tethys.	nf.
	19·2	Mimas.	e.
	19·2	Dione.	nf.
	23·4	Encel.	sp.
	2·6	Tethys.	e.
	2·9	Dione.	sp.
	4·5	Encel.	w.
5	17·4	Tethys.	sp.
	17·9	Mimas.	e.
	20·9	Encel.	e.
	1·3	Tethys.	w.
	2·0	Encel.	sf.
	4·1	Dione.	np.
	5·2	Mimas.	w.
6	16·1	Tethys.	nf.
	16·5	Mimas.	e.
	18·5	Encel.	np.
	0·0	Tethys.	e.
	0·4	Dione.	e.
	0·9	Encel.	nf.
	3·9	Mimas.	w.
	5·9	Encel.	e.

1876.	Gr. Sid. Time. h.		
7	17·2	Rhea.	inf. s.
	17·3	Encel.	sp.
	20·7	Dione.	sp.
	21·7	Rhea.	sp.
	22·4	Encel.	w.
	22·7	Tethys.	w.
	2·5	Mimas.	w.
	3·4	Encel.	np.
8	19·9	Encel.	sf.
	20·3	Rhea.	w.
	21·4	Tethys.	e.
	21·9	Dione.	np.
	1·2	Mimas.	w.
	2·3	Encel.	sp.
	5·3	Tethys.	sf.
	5·7	Dione.	nf.
9	18·3	Dione.	e.
	18·8	Encel.	nf.
	19·0	Rhea.	np.
	20·1	Tethys.	w.
	23·5	Rhea.	sup. n.
	23·8	Encel.	e.
	23·9	Mimas.	w.
	4·0	Rhea.	nf.
	4·0	Tethys	np.
	4·9	Encel.	sf.
10	16·3	Encel.	w.
	18·8	Tethys.	e.
	21·4	Encel.	np.
	22·6	Mimas.	w.
	2·7	Rhea.	e.
	2·7	Tethys.	sf.
	3·2	Dione.	w.
	3·8	Encel.	nf.
11	17·5	Tethys.	w.
	20·2	Encel.	sp.
	21·3	Mimas.	w.
	23·5	Dione.	nf.
	1·3	Encel.	w.
	1·3	Rhea.	sf.
	1·4	Tethys.	np.
	5·8	Rhea.	inf. s.
12	16·3	Tethys.	e.
	17·8	Encel.	e.
	19·9	Mimas.	w.
	22·8	Encel.	sf.

1876.	Gr. Sid. Time. h.		
	0·1	Tethys.	sf.
	0·7	Dione.	sf.
	4·5	Dione.	inf. s.
13	? 16·	Iapetus	sup. 15″ s.
	18·6	Mimas.	w.
	21·0	Dione.	w.
	21·7	Encel.	nf.
	22·9	Tethys.	np.
	2·8	Encel.	e.
	5·8	Tethys.	nf.
	5·9	Mimas.	e.
14	16·6	Rhea.	nf.
	17·3	Mimas.	w.
	17·3	Dione.	nf.
	19·3	Encel.	w.
	21·6	Tethys.	sf.
	0·3	Encel.	np.
	4·5	Tethys.	sp.
	4·6	Mimas.	e.
	5·9	Dione	e.
15	16·0	Mimas.	w.
	16·8	Encel.	sf.
	18·5	Dione.	sf.
	20·3	Tethys.	np.
	22·4	Dione.	inf. s.
	23·2	Encel.	sp.
	2·2	Dione.	sp.
	3·2	Tethys.	nf.
	3·3	Mimas.	e.
	4·2	Encel.	w.
16	18·4	Rhea.	inf. s.
	19·0	Tethys.	sf.
	20·7	Encel.	e.
	23·0	Rhea.	sp.
	1·7	Encel.	sf.
	1·9	Tethys.	sp.
	2·0	Mimas.	e.
	3·4	Dione.	np.
17	17·7	Tethys.	np.
	18·2	Encel.	np.
	21·6	Rhea.	w.
	23·8	Dione.	e.
	0·6	Encel.	nf.
	0·6	Tethys.	nf.
	0·7	Mimas.	e.
	5·7	Encel.	e.
18	15·3	Titan	inf. 28″ s.
	16·2	Dione.	inf. s.
	16·4	Tethys.	sf.
	17·1	Encel.	sp.
	20·1	Dione.	sp.
	20·3	Rhea.	np.
	22·1	Encel.	w.
	23·3	Tethys.	sp.

1876.	Gr. Sid. Time. h.		
	23·3	Mimas.	e.
	0·8	Rhea.	sup. w.
	3·2	Encel.	np.
	5·3	Rhea.	nf.
19	19·7	Encel.	sf.
	21·3	Dione.	np.
	22·0	Mimas.	e.
	22·0	Tethys.	nf.
	2·1	Encel.	sp.
	3·9	Rhea.	e.
	5·0	Dione.	nf.
	5·9	Tethys.	e.
20	17·6	Dione.	e.
	18·5	Encel.	nf.
	20·7	Mimas.	e.
	20·7	Tethys.	sp.
	23·6	Encel.	e.
	2·6	Rhea.	sf.
	4·6	Tethys.	w.
	4.6	Encel.	sf.
21	16·1	Encel.	w.
	19·4	Mimas.	e.
	19·5	Tethys.	nf.
	21·1	Encel.	np.
	2·5	Dione.	w.
	3·3	Tethys.	e.
	3·5	Encel.	nf.
22	18·0	Mimas.	e.
	18·2	Tethys.	sp.
	20·0	Encel.	sp.
	22·8	Dione.	nf.
	1·0	Encel.	w.
	2·1	Tethys.	w.
	5·4	Mimas.	w.
23	16·7	Mimas.	e.
	16·9	Tethys.	nf.
	17·5	Encel.	e.
	17·9	Rhea.	nf.
	22·6	Encel.	sf.
	0·0	Dione.	sf.
	0·8	Tethys.	e.
	3·9	Dione.	inf. s.
	4·1	Mimas.	w.
	5·0	Encel.	sp.
24	16·6	Rhea.	e.
	20·4	Dione.	w.
	21·5	Encel.	nf.
	23·5	Tethys.	w.
	2·5	Encel.	e.
	2·7	Mimas.	w.
25	16·7	Dione.	nf.
	19·0	Encel.	w.
	19·7	Rhea.	inf. s.
	22·2	Tethys.	e.

1876.	Gr. Sid. Time.		
	h.		
	0·0	Encel.	np.
	0·2	Rhea.	sp.
	1·4	Mimas.	w.
	5·3	Dione.	e.
26	16·5	Encel.	sf.
	17·9	Dione.	sf.
	20·9	Tethys.	w.
	21·7	Dione	inf. s.
	22·9	Rhea.	w.
	22·9	Encel.	sp.
	0·1	Mimas.	w.
	1·6	Dione	sp.
	4·0	Encel.	w.
	4·8	Tethys.	np.
27	19·6	Tethys.	e.
	20·4	Encel.	e.
	21·5	Rhea.	np.
	28·8	Mimas.	w.
	1·5	Encel.	sf.
	2·1	Rhea.	sup. n.
	2·8	Dione.	np.
28	18·0	Encel.	np.
	18·3	Tethys.	w.
	21·4	Mimas.	w.
	23·1	Dione.	e.
	0·4	Encel.	nf.
	2·2	Tethys.	np.

1876.	Gr. Sid. Time.		
	h		
	5·2	Rhea.	e.
	5·4	Encel.	e.
29	16·8	Encel.	sp.
	17·0	Tethys.	e.
	19·4	Dione.	sp.
	20·1	Mimas.	w.
	21·9	Encel.	w.
	0·9	Tethys.	sf.
	2·9	Encel.	np.
	3·9	Rhea.	sf.
		Moon near.	
30	18·8	Mimas.	w.
	19·4	Encel.	sf.
	20·6	Dione.	np.
	23·6	Tethys.	np.
	1·8	Encel.	sp.
	4·4	Dione.	nf.
Oct. 1	17·0	Dione.	e.
	17·5	Mimas.	w.
	18·3	Encel.	nf.
	22·3	Tethys.	sf.
	23·4	Encel.	e.
	4·4	Encel.	sf.
	4·8	Mimas.	e.
	5·3	Tethys.	sp.
	5·6	Dione.	sf.

Differences of right ascension and declination of Titan and Iapetus and of the centre of Saturn. At 0h. Gr. Sider. Time.

	Titan.		Iapetus.	
	α—A.	δ—D.	α—A.	δ—D.
1876.	s.	"	s.	"
Sept. 1	+3·30	—31·1	—31·27	—34·8
2	—1·74	24·6	29·37	34·2
3	6·52	14·3	27·27	33·3
4	10·28	—1·8	24·98	32·1
5	12·39	+11·1	22·53	30·7
6	12·45	22·2	19·93	29·2
7	10·44	29·7	17·19	27·4
8	6·69	32·3	14·34	25·5
9	—1·83	29·6	11·39	23·4
10	+3·32	22·2	8·36	21·1
11	7·95	+11·2	5·28	18·8
12	11·39	—1·4	—2·16	16.3
13	13·16	14·0	+0·97	13·7
14	13·05	24·6	4·08	11·1
15	11.10	31·8	7·17	8·5
16	7·58	35·4	10·20	5·8
17	+2·99	32·4	13·15	3·1
18	—2·03	25·6	16·01	—0·4
19	6·73	14·9	18·75	+2·2
20	10·38	—1·8	21·36	4·8
21	12·36	+11·5	23·81	7·3
22	12·30	23·0	26·10	9·7
23	10·19	30·8	28·20	12·0

24	6·38	33·4	30·11	14·2
25	—1·54	30·6	31·80	16·2
26	+3·55	22·8	33·27	18·1
27	8·09	+11·5	34·51	19·8
28	11·40	—1·5	35·51	21·4
29	13·c5	14·4	36·28	22·7
30	12 83	25·3	36·80	23·9
Oct. 1	+10·81	—32·6	+37·07	+24·9

Elongations of the five inner satellites at oh. Gr. Sid. Time of every fifth day.

1876.	Mimas.		Encel.		Tethys.		Dione.		Rhea.	
	l.	diff.	l.	diff.	l.	diff.	l.	diff.	l.	diff.
Sept.	°	°	°	°	°	°	°	°	°	°
2	124·5	1905·0	57·1	1310·4	49·0	951·2	282·7	656·2	164·9	397·7
7	229·5	·0	287·5	0·3	280·2	·2	218·9	·2	202·6	·7
12	334·5	·0	157·8	0.4	151·4	·1	155·1	·2	240·3	·6
17	79·5	1905·0	28.2	0·3	22·5	·2	91.3	·1	277·9	·7
22	184·5	1904·9	258·5	0·3	253·7	·1	27·4	·1	315·6	·6
27	289·4	·9	128·8	1310 2	124·8	951·1	323·5	656·1	353·2	397·6
Oct.										
2	34·3		359·0		355·9		259·6		30·8	

These values must be interpolated for the times for which the places of the satellites are required. To get the elongations for the even hours between 18h. and 4m· Gr. Sid. Time., it will be sufficient to add the following angles to the values of l. given directly in the table (360° being subtracted, when needed) on the day for which l. is given.

	h.	Mimas.	Encel.	Tethys.	Dione.	Rhea.
		°	°	°	°	°
At	18	264·8	294·5	312·5	327·2	340·1
	20	296·5	316·3	328·3	338.1	346·8
	22	328·3	338·2	344·2	349·1	353·4
	0	0·0	0·0	0·0	0·0	0·0
	2	31·8	21·8	15·9	10·9	6·6
	4	63·5	43·8	31·7	21·9	13·2
On the first day following—						
At	18	285·8	196·6	142·7	98·4	59·7
	20	317·5	218·4	158·5	109·3	66·3
	22	349·3	240·2	174·4	120·3	72·9
	0	21·0	262·1	190·2	131·2	79·5
	2	52·8	283·9	206·1	142·1	86·2
	4	84·5	305·8	221·9	153·1	92·8
On the second day following—						
At	18	306·8	98·6	332·9	229·6	139·2
	20	338·5	120·5	348·7	240·5	145·8
	22	10·3	142·3	4·6	251·5	152·5
	0	42·0	164·2	20·4	262·4	159·1
	2	73·8	186·0	36·3	273·3	165·7
	4	105·5	207·8	52·1	284·3	172·3
On the third day following—						
At	18	327·8	0·7	163·1	0·8	218·8
	20	359·5	22·6	178·9	11·7	225·4
	22	31·3	44·4	194·8	22·7	232·0
	0	63·0	66·2	210·6	33·6	238·6
	2	94·8	88·1	226·5	44·5	245·2
	4	126·5	109·9	242·3	55·5	251·9
On the fourth day following—						
At	18	348·8	262·8	353·3	132·0	298·3

20	20·5	284·6	9·1	142·9	304·9
22	52·3	306·5	25 0	153·9	311·5
0	84·0	328·3	40·8	164·8	318·1
2	115·8	350·2	56·7	175·7	324·8
4	147·5	12·0	72·5	186·7	331·4

The rectangular co-ordinates x″, y″ of the satellites, reckoned parallel to the axes of the ring, are then found by $x'' = a \sin l$, and $y'' = b \cos l$, and the polar-co-ordinates p and s by

$$s \sin (p - 6^\circ{\cdot}2) = a \sin l.$$
$$s \cos (p - 6^\circ{\cdot}2) = b \cos l.$$

where a and b are the semi-axes of the apparent orbits. Their values are found in the following table, the last columns of which give the hourly changes of the co-ordinates of fixed stars parallel to the axes of the ring.

	Mimas.		Encel.		Tethys.		Dione.		Rhea.		Hourly change.	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	of *x″*	of *y″*
Sept.	″	″	″	″	″	″	″	″	″	″	″	″
2	29·2	4·1	36·6	5·1	46·4	6·5	59·5	8·3	83·0	11·7	+10·0	+5·3
7	29·2	4·2	36·6	5·2	46·3	6 6	59·4	8·5	82·9	11·9	9·7	5·1
12	29·1	4·3	36·5	5·3	46·2	6·8	59·2	8·7	82·7	12·1	9·4	4·9
17	29·0	4 3	36·4	5·4	46·1	6·9	59·0	8·8	82·5	12·3	8·9	4·6
22	28·9	4·4	36·2	5·5	45·9	7·0	58·8	8.9	82·2	12·4	8·3	4·2
27	28·8	4·4	36·1	5·5	45·7	7·0	58·5	9·0	81·8	12·6	7·7	3·8
Oct.												
2	28·6	4·5	35·9	5·6	45·5	7·1	58·2	9·1	81·3	12·7	+6·9	3·4

A. M.

ECLIPSE OF THE MOON.

A partial eclipse of the moon, visible at Greenwich, will take place on September the 3rd.

	G. M. T.	
	h.	m.
First contact with the penumbra, September 3.	6	47·5
First contact with the shadow	8	15·4
Middle of the eclipse	9	22·3
Last contact with the shadow	10	29·2
Last contact with the penumbra	11	57·1

Magnitude of the eclipse (moon's diameter = 1) 0·341.

The first contact with the shadow occurs at 8° from the northernmost point of the moon's limb towards the east.

The last contact at 63° towards the west; in each case for *direct* image.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To Dec., 1875.
Browning, J.

To Sept., 1876.
Lewis, H. K.

To Oct., 1876.
Calver, G.
Hargreaves, T.

To Dec., 1876.
Hubbersty, Rev. R. C.
Padbury, J.

To Jan., 1877.
Hutchings, Rev. R.S.

To June, 1877.
D'Alquen, F. M.
Gooch, Miss

To Sept., 1877.
Corbett, C. J.

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The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Rev. J. C. Jackson, *Clarence Road, Clapton, E.*, **not later than the 15th of the Month.**

The Astronomical Register.

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SELENOGRAPHY—PAST, PRESENT AND FUTURE.

By W. R. Birt, F.R.A.S.

In offering a few thoughts on the present state of Selenography, it will be well to glance at its literature—pictorial representations by maps, drawings, and monograms—and its progress by means of observation.

Literature. The recent appearance of *three* works on the moon betokens a healthy condition of research into her motions and the nature and condition of her surface. As bearing on such of her movements as are of the greatest utility to the inhabitants of the earth, the first and third treat more or less extensively of that triumph of mathematical investigation, "the lunar theory," and as illustrating more particularly by exquisite specimens of photography the telescopic appearance of the moon, the second claims attention, the text being principally devoted to an exposition of the author's views of volcanic agency in modifying the surface of our satellite. We shall notice this work under the head of pictorial representations.

The work best calculated in our opinion to advance Selenography is Neison's, containing as it does a description of *every named* object or formation. The descriptions given by the author supply a deficiency in the English literature of this branch of astronomy, and if they be well studied and diligently compared with the moon itself, they cannot fail considerably to extend our knowledge and induce a much greater interest in the science than has hitherto been manifested. Before, however, we dismiss our notice of this work, we

would just call attention to the present state of lunar nomenclature. Webb's "Celestial Objects for common telescopes," up to the time of the appearance of Neison's work was the only authority for lunar nomenclature since the epoch of Mädler. Neison's book contains a rather more extended list of named objects than Webb's, but as Neison has rejected some of Webb's names, and increased the list by several others, and as Webb's book is most deservedly popular, we apprehend that both must be considered as authorities in this matter.

Pictorial representations. The splendid photograms by Nasmyth claim, in the first instance, a few remarks. The telescopic appearance of certain selected parts of the moon is most vividly brought before the eye, perhaps in a much greater degree than by the striking photograms of Rutherfurd, which occupy by far the first place in moon-painting; there is, however, this difference between Nasmyth and Rutherfurd: one has given the results of a fertile artistic genius, the other has furnished us with transcriptions of the moon's face delineated by her own beams; the artistic representations by Nasmyth require *confirmation* by comparison with the moon itself, and this is their only utility, as the detection of errors will lead to a better acquaintance with the original, while without any comparison with the moon each examination of the photograms of Rutherfurd is equivalent to a personal observation of our satellite.

Next to photographic representations of the moon, the map in twenty-two sections, illustrating Neison's work, must doubtless take the place of Beer and Mädler's. Although on a smaller scale it contains much detail, still there is much at least to supply if not to correct—on this point we shall speak by and by.

It would not be doing justice to the earnest student if we were to pass over our own contributions to Selenography. It is our earnest desire that the four sections of the British Association map may become for the 100 square degrees delineated the standard of reference for all the known objects contained in them, each having been numbered and described in the catalogue accompanying them. In the same way all known objects on the Mare Serenitatis are mapped and catalogued in the monogram of the Mare—about 50 copies only of this monogram are on hand.

Observation. Nothing can contribute so much to the advancement of Selenography as observation, the printed records of which are far behind its published literature, indeed there is no recognised medium in which selenographical observations are exclusively published, and this is a serious drawback to its progress. Some few years since the *English Mechanic* inserted notices of observations, and again of late a few have appeared, but it is many years

since any observations of lunar topography have been communicated to the Royal Astronomical Society, indeed some fourteen or fifteen years ago the Council rather objected to receive such. A most important point in the publication of selenographical observations is the *designation* of the objects seen; as regards this point we have noticed—and we beg to direct particular attention to them—two methods, one which we may regard as that characterising the drawings inserted from time to time in the *English Mechanic*, the other the British Association method; in the first, the objects are arbitrarily numbered by each observer, the consequence being that the *same* object has mostly a different number in each, and thus necessarily two or more collations are required before the British Association designation can be applied. The only remedy for this is that each observer who desires to do efficient work should be in correspondence with some one who can undertake to keep the registration of the various formations *en courant* with observation, using only the British Association symbols published in the report of the Lunar Committee for 1865. As no central office exists to which correspondence of this kind can be addressed, we shall be happy to furnish such information from the existing registers, containing between two and three thousand distinct objects, as will enable observers to carry on the registration from the last symbol entered in any area. Time and space will not allow us to particularise the last object entered in each of the 324 areas published in the British Association report, 1865, pp. 288 to 290, but we shall be happy to inform any correspondent of the condition of any area he may select.

Observations are particularly needed to supply deficiencies and to ascertain if all the objects inserted both in earlier and later maps and monograms are in existence. This may be dry work, but the necessity for it is certainly characteristic of the present state of Selenography. The most advanced selenographer amongst us will readily testify that the condition of by far the greater portion of the surface of our satellite as regards minute detail, and the aspects which the smaller objects present from time to time, is a perfect *terra incognita* to observers. Changes *may actually have taken place* in more than one locality during the last fifteen years, of which no evidence is on record, simply because such localities have not passed under the review of selenographical observers. Time is an important element in discovery; the continued labours of Schmidt led to the suspected change in *Linné*, and constant watch kept on this object is of the utmost importance, and it is no less important that observations of it and its surroundings should be periodically published, lest an alteration should again pass unnoticed for several years.

THE THERMOGRAPHY OF THE SUN.

If any one who understands the English language will first read my paper on "A Method of obtaining Thermographs of the Isothermal Lines of the Solar Disc," and will then read Dr. O. Lohse's criticism thereon, he may see that the greater part of his objections to my paper is caused by his not understanding the full force and exact meaning of English expressions. He is specially sharp in his comments on this paragraph: "As far as the few observations have any weight, the following appear to be the discoveries made by this method." I am sure that an Englishman will not interpret the above sentence as expressing positive assurance in the mind of the writer, yet Dr. Lohse reads this sentence otherwise, and attacks me for expressing myself so confidently. Again, when I say "this may create a new branch of solar physics," Dr. Lohse thinks I have said, *will create,* for he comments on my surmise thus: "I am not so *fully convinced* as Mr. Alfred Mayer that by employing thermographic methods an entirely new branch of physics *has been* created for solar physics."

I see no reason in Dr. Lohse's objection to the use of the words "isothermal lines," as indicating the lines of equal temperature in the unequally heated solar image. Pray, what does Dr. Lohse call those lines which pass through points of equal temperature?

The remaining remarks of Dr. Lohse on the errors to which the process is liable would not have been written had he read my second paper (*Nature,* October, 1875) in which I not only point out these errors, but show their cause, and then give the methods by which they can be reduced to their minimum amount.

It was not until several months after the publication of my second paper that I became acquainted with the fact that Dr. Lohse had partly anticipated my discovery by the publication of a paper in the *Astronomische Nachrichten.* Whatever is similar in our publications belongs to Dr. Lohse. The rest of the process —the method of obtaining isothermal lines on the solar image— is entirely new, and does not appear to have been tested by Dr. Lohse before he wrote his criticisms. Indeed, he could not have tested it without the use of the method described by me in my second paper.

I do not desire that this communication should be taken as an apology for any errors I may have made. The only men of science who make mistakes are *the workers*—those who are secure from all such accidents are those who *do nothing.*

(Signed) DR. ALFRED M. MAYER.

REVIEWS.

The Moon and the Conditions and Configurations of its Surface. By Edmund Neison, Fellow of the Royal Astronomical Society, &c. Illustrated by maps and plates. London: Longmans, Green & Co. 1876.

(Continued from page 214.)

We have found one fault in our examination of this work, and that is a degree of carelessness in its style. Sometimes sentences do not hang well together, and would be better for being recast. Syntax and punctuation might be improved in some places, and redundancy of expression pruned away in others. These blemishes may easily be removed in a future edition. We now go on to Chapter III. on the lunar formations, from which we extract the following:—

"The entire visible surface of the moon may be divided into three great classes, under which the whole of the diversely constituted lunar surface may, for convenience, be grouped—namely, the plains, craters, and mountains; the term craters being used only in its usual conventional sense. The first class, which occupies more than half the entire lunar surface, is divisible into the two great sub-classes of dark and light plains; the first including the lunar Mares with the smaller formations to which the the terms Palus, Lacus, and Sinus have been applied; whilst the formations comprised in the latter class have received no distinct name, and seldom possess as definite borders as the former. Under the single term craters, in compliance with the conventional usage of the name, have been grouped the whole mass of the formations of the moon, which, when viewed with a low power and a small aperture, are supposed to bear some resemblance in appearance to the volcanic craters, though they are of the most diverse nature, and mostly without the slightest claim to be regarded as such. These formations will be divided into nine classes—namely, walled-plains, mountain-rings, ring plains, crater-plains, craters, craterlets, crater-pits, crater-cones, and depressions; each of which possess distinctive features, though the lines of demarcation are of necessity somewhat arbitrary. Finally, the mountain formations may also conveniently be separated into twelve classes—namely, the great ranges, highlands, mountains, and peaks constituting the greater elevations; and hill-lands, plateaus, hills, and mountain ridges, forming the lesser elevations; whilst the numerous small irregularities of the surface are comprised in the four divisions of hillocks, mounds, ridges, and land-swells." All these are described in detail, and then we come to a feature impossible to be placed under any one of the three great classes. "These are the *rills* or *clefts*, long, narrow, deep ravines, canals, or cracks, usually straight, often branched, sometimes curved, and not unusually intersecting one another; extending for considerable distances at times, generally traversing, without interruption, mound, ridge, or crater-pit in their path, though occasionally deflected by some object, or interrupted by others, when it recommences beyond and proceeds as before. One of the most difficultly visible, they are also one of the most inexplicable formations on the moon, and little information as to their origin can be derived from their situation, which is most diverse, at times lying on the open plains without anything to indicate beginning or end, often running through the midst of mountains, or extending from a crater to the open plain; at others they appear to form an intricate network around a formation, or are situated on the floor of a walled-plain or ring-plain." These formations, first discovered by Schröter, who detected eleven, may now be estimated at probably nearly 1000; whilst every year the labours of a very few observers only are adding fresh examples to those already known.

Mr. Neison says, "With regard to the true nature of these rills or clefts absolutely nothing is known, whilst they are too delicate objects to allow much, if any, of the details of their formation to be made out. It has been supposed they are cracks or fractures in the lunar surface; but their intersection and general condition of existence seem quite inconsistent with such a suggestion, more especially in their behaviour with reference to the various formations they pass through, round, or over. In many points they bear some resemblance to the dried beds of lunar water-courses or rivers, but in many features do not seem in accord with such an origin, though perhaps it presents the most feasible explanation of their nature of all; but their true nature will not be ascertained until they have been made the subject of a searching examination with a powerful telescope of the highest excellence, and thus details of the method of their construction have been obtained . . . . An especial feature is their remarkable length, in some instances extending for over 200 to 300 miles."

A scale of light for recording the relative brightness of different portions of the moon was first introduced by Schröter: that adopted in this volume is after Mädler's. It is 0° for the dark lunar shadows, 1° to 3° of grey, 4° to 5° gradations of light grey, 6° to 7° greyish white, 8° to 10° brilliant white. The brightest region upon the moon is that of Aristarchus, the immediate environs being 9°, the outer walls and interior 9°—10°, the interior walls 10°, and the central peak perhaps still brighter.

Perhaps the greatest puzzle connected with its surface are the systems of radiating streaks which the full moon presents in all their splendour. "Seven of the principal formations of the moon, Tycho, Copernicus, Kepler, Byrgius, Anaxagoras, Aristarchus, and Olbers, being environed by numerous bright rays or streaks radiating from them far and wide, while to a less marked degree a similar appearance presents itself around Mayer, Euler, Proclus, Aristillus, Timocharis, and some others. These rays or streaks ordinarily commence at a slight distance from the walls, the immediate environs being comparatively dark, generally only 4° bright, or at Aristarchus only 2°, and then extend great distances, for 100, 200, and 500 miles, over plains, craters, mountains, valleys, and all formations without distinction, or without in any way being modified or modifying. Close to their origin the rays by their union form a kind of nimbus around the radiating centre of very variable dimensions, that at Kepler being largest, and at Aristarchus hardly perceptible, whilst beyond this nimbus they extend usually straight but often branched, though occasionally curved, as at Copernicus and Anaxagoras. In some cases the rays end sharply at a crater or ring-plain, others lose themselves in the bright regions of the limb, whilst many gradually disappear on the plains or amongst the mountains. The most extensive system is that of Tycho, where many hundred separate rays can be distinguished, mostly ten to twenty miles broad, extending over nearly the entire S.W. quadrant of the moon, and over a considerable portion of the S.E. quadrant; some of the rays losing themselves in the Mare Nubium and Oceanus Procellarum, after traversing a distance of 600 or 700 miles, while one crosses nearly the entire visible hemisphere, becoming nearly imperceptible at Menelaus, but very distinct again when passing over the Mare Serenitatis, and disappearing finally in the bright region of the limb beyond Thales, a distance of nearly 2,000 miles. When these rays are numerous they completely overpower all differences in light-reflective power in the formations they traverse, and which consequently vanish in their light; from which circumstance few formations in a great

portion of the S.W. region of the moon are detectable under high illumination. There are also many isolated streaks of various kinds. Messier has completely the form of a faint comet with a long double tail, the nucleus being Messier itself, and the tails two long white streaks of equal size, gradually widening and losing themselves in the mountains . . . . The true nature of these rays and the origin of the ray-systems is at present unknown, though it appears that thay are not merely surface-elevations, such as the mountain ridges, &c., and Beer and Mädler regard them as perfectly independent of all surface formations, which, however, later observations with more adequate means do not entirely confirm. The most obvious course would appear to be to connect them with some processes of weathering or surface action, but of what nature there does not appear to exist any evidence, and this alone affords no clue to the reason of their radiating from a centre, as shown in the most prominent systems . . . . The true solution of the origin of these streaks or rays will probably not be found until their appearance has been made the subject of a thorough investigation, so as to make known the more delicate features they present."

On the subject of peculiarities of colour, we find that the surface of the moon exhibits every kind of variation of pale yellow, grey, and white, and in many places the yellow merges almost into a pale brown. Under favourable conditions, the following distinct specific differences in colour are visible: "The entire central portion of the Mare Serenitatis appears with a decided light green tinge, while in the Mare Humorum is a somewhat duskier tinge of green, and a fainter but similar appearance is noticeable in the Mare Crisium. The Mare Frigoris appears likewise to be of a dull, dirty yellowish green, at times more brownish-yellow than green, and a similar appearance is, under favourable conditions, detectable in the Mare Imbrium, whilst the Palus Somnii exhibits a peculiar golden-brown colour, very noticeable under certain conditions."

Chapter V. is on variations of the surface. Although various indications of apparently physical changes have been recognised by all selenographers, Mädler and Schmidt included, they cannot be said as yet to have been definitely established. Mr. Neison thus writes on the subject: "That physical changes of various characters must be still occurring upon the moon is rendered certain by the results obtained by Lord Rosse with regard to the variations in temperature of the lunar surface, for the alternate heating and cooling of the lunar strata, from the nature of the expansion and contraction thus brought into play, must, through numerous fractures and the resulting general disintegration, gradually ruin all the lunar formations." But though such changes, whether through earth-falls, landslips, and analogous effects, are questioned by few or none, they do not properly come under the category of physical changes; and an instance on a sufficiently vast scale to be recognised from the earth must be excessively rare. "The question," Mr. N. continues, "of physical changes on the moon's surface is generally and with justice held to apply only to such instances as can be detected telescopically, such as might be expected to be the case with manifestations of volcanic activity, processes of vegetation, periodical changes in the nature of the lunar surface of marked character, &c. It is very generally maintained that no instances of such a nature are any longer possible on the moon, and, as already mentioned, many selenographers allow that no such instance has been established, though its probability may have been rendered more or less certain, whilst others, including some of the most experienced, consider that in several cases the existence of such changes has been demonstrated." And in regard to the difficulty of distinguishing purely optical

variations in appearance, due to differences in illumination and libration, from what may with any degree of probability be regarded as due to actual alteration in the form or position of the object; he says, "This circumstance, while rendering it necessary to employ great caution, also renders it still more necessary not to regard the absence of any established instance of such changes as indicative of the entire permanency of the lunar formations. So little known are the minor details of the moon, that, except in a very few regions, a very considerable alteration of the present constitution of the surface might occur at any moment, without the slightest probability of its being detected as an instance of physical change on the moon. Thus, for example, if on the moon proportionately the same amount of volcanic energy were every year manifested in a similar manner to what occurs on the earth, there is no reason whatever for supposing that it would have been hitherto detected. With the present condition of our acquaintance with the topography of the lunar surface in this state, it is not in the least degree surprising that no definite instance of volcanic energy has hitherto unmistakably declared itself. Nor can this circumstance justify its being held that volcanic activity in the moon must have long ere this entirely ceased to exist." This appears to us to be sound doctrine.

We next come to a description of the variation in appearance of a ring-plain in the course of a lunation (which is in fact a lunar day) which is admirably given, and which we transcribe without abridgment. "Selecting any particular formation, and watching it from the period when the earliest beams of sunlight commence to fall on its nearest and loftiest point, until the whole finally disappears in the dark shades of night, a very remarkable and interesting series of changes in its appearance will be seen, and experience of great value in studying the nature of the surface will be obtained. Choosing as a typical class of lunar formations some fine ring-plain towards the centre of the moon; first, far within the dark side of the moon, will be seen faintly glittering the summits of the loftiest wall-peaks on the nearest wall; these gradually growing distinct and permitting the extreme crest of the wall to be detected. Soon after appears the exterior slope of the formation, with its short shadows and generally rugged form. Long after the extreme slope of the walls has become distinct, and when the minor detail is losing distinctness, a glittering point appears perhaps far within the darkness, and soon another and another, until, on favourable occasions, the thus early illuminated peaks of the farther wall glitter like a semicircle of brilliants rising out of the darkness. As the illumination proceeds, the wall of the ring-plain forms a bright circle of light surrounding a black chasm, the interior terraces and spurs of the farther wall standing out boldly. Suddenly a faint streak breaks across the darkness, usually followed closely by a second and a third, until, seemingly rapidly widening, the whole gradually resolves into a system of long spire-like shadows from the wall-peaks. As these spurs of shadow shorten, numerous ridges, mounds, and other irregularities on the floor make a transient appearance, whilst the ruggedness of the walls softens down and slowly becomes imperceptible. By the time the shadows have crept close to the border-wall, the summits of the terraces, and the smaller irregularities of the interior nearer wall, and exterior farther wall, a pear rising through the darkness, until, usually some thirty-six hours after sunrise, the ring-plain stands out distinctly, free from great masses of shadow, only a few steep peaks and the terraces and irregularities on the interior nearer slope casting shadows. But though free from shadow, the farther slopes of the irregularities and walls, less brilliantly illuminated by the sun,

seem, from their comparatively grey appearance, still to possess faint shadows. Hitherto differences in brightness in the formations have been very slight; but as the details of the whole ring-plain gradually soften down and fade out of sight in the slowly increasing angle of illumination, strong differences in tint and brightness begin to manifest themselves in a striking manner. On the floor will appear grey streaks, white lines and spots, and perhaps even dark grey patches. the whole lying on a background of fine yellowish grey of different tints and intensities; whilst the walls usually assume a bright greyish white appearance, with here and there a spot or streak of grey or yellow. By the time these varieties have once come strongly into view, which is usually some three days before Full, and two after the disappear nce of the shadows, all the minor details visible as irregularities on the surface have disappeared, and the whole formation takes the character of a surface-marking, except in the very finest telescopes, and under atmospheric conditions of great excellence. Much, however, can often be made out under these conditions from the variations in brightness, which also, when the ground is familiar, will enable all the principal details of the formation to be made out. . . . . Moreover, many of the more extensive but more gentle formations and surface conformations, which from the slight shadows they cast at sunrise are easily overlooked, even when not entirely masked by much smaller though more abrupt and then more striking irregularities, at Full can be made out with distinctness from their differences in brightness.

"From this period to two or three days af er Full, this characteristic appearance is maintained, the minor differences in the intensities and position of the light-markings being slight, though valuable as affording a clue to the real nature of the surface. Soon after the third day after Full, the differences in tint and brightness commence to fade; grey tints put in their appearance, and faint shadows may gradually be detected. The farther interior wall commences to grow rugged then the nearer exterior wall; shadows at first just perceptible grow long, and numerous surface irregularities spring into view. Then follows the reversal of the phenomena of sunrise; first, the interior of the far wall, then the exterior of the near wall disappear into shadow, which next creeps along the interior; long spires shoot out and widen, until soon the whole floor lies immersed in night. Slowly the shadow mounts the opposite wall, crowns the summit, and leaves far within the shade of night a few glittering peaks like stars. One by one these fade out of view, and the far wall of the ring-plain stands out in giant relief against the dark terminator. Next the plain at the foot of the formation is immersed in darkness, which now creeps up the wall of the formation. soon to cover all in the folds of night, except perhaps one or two lofty peaks, which towering aloft to an immense height, often glitter in the last rays of sunset long after the rest of the formation has been wrapped in darkness for another lunar night."

The effects produced by libration are next considered, which, combined with those of varied illumination, occasion great changes in the apparent nature of the formations. But though the appearance and relative visibility of different objects are affected by this to a considerable extent, Mr. Neison thinks that its influence has been much overrated, and that a little experience and care will in most cases obviate all trouble arising from it. After discussing the subject he concludes thus: "Therefore the lunar librations, though of the greatest importance in mapping or drawing the surface of the moon, and necessary to be taken into consideration in studying the surface, cannot justly be held to be the great difficulty in selenographical research they are commonly supposed, nor yet can they

be properly held as sufficient to account for any changes whatever in the appearance of the details of the surface. This conclusion is analogous to that of Mädler, who recognised that, except near the limb, the lunar librations would not interfere with the detection of physical changes upon the surface of the moon ; and its justice will be recognised after studying well any portion of the surface, so as to become thoroughly familiar with its appearance and nature ; it will then be seen that, except in the smaller detail of the moon, where the conditions of the terrestrial atmosphere exert more influence than any change due to libration, variations in the appearance of the nature of the surface are far less extensive than is generally supposed. It is only where the region is not well known that the changes due to libration appear great or startling."

The well known instance of supposed physical change in Linné (or in the Latin form Linnæus) is amply discussed, and more minutely in chap. ix., and the puzzling subject is treated with good judgment. "On only one basis," Mr. Neison observes, "can the fact of a real change in Linné be established, if indeed it be really a fact, and that is by demonstrating that a similar alteration has occurred under similar conditions elsewhere : and if processes of actual change are still at work on the moon's surface of sufficient power to produce alterations of such magnitude as in the supposed case of Linné, then they must occur in course of time in other formations as well, where systematic series of observations will reveal their action." And the following remarks appear to have much probability : "It has been generally assumed that if any change in Linné has occurred its nature must have been volcanic, and resulted in either filling up the crater, or else by producing a fixed low cloud over its site-hidden Linné. Neither of these conditions seems what is indicated by observations, and it does not appear that there exists any reason for supposing a volcanic change to have taken place ; but the alteration, if any, appears to have been of a different nature. According to Lohrmann and Mädler's description, it would appear that Linné belonged to the class of deep and steeply walled craters, and the change, if any, appears to have been simply the falling of the walls into the interior of the crater, filling this in great part up with the *débris*, a class of occurrences of which several hundred instances could be pointed out where it has happened, and in particular the north-west wall of Gassendi, which lies in ruins on the exterior plain. And all the observations seem to concur in pointing to an instance of this having occurred, and Linné to have disappeared as a conspicuous object from its steep walls tumbling into the interior."

There are other instances of apparently physical change, which, however, are still held to be doubtful; but the case of Messier, a pair of small ring-plains, about eight miles in diameter, close together and isolated on the Mare Fœcunditatis, is particularly remarkable. "In connection with one of these two formations, Schröter had suspected some physical change, so that Beer and Mädler determined to give especial attention to them. Three hundred separate observations of these two ring-plains were made by B. and M. between 1829 and 1837, for the express purpose of detecting any variation between them, with the result of establishing that during the whole of this period the two ring plains appeared *completely alike*. In diameter, form, height, depth, colour of the interior and of the walls, positions of the wall-peaks, these two objects were exactly alike ; and B. and M. italicise this in their way, so that no question can be raised as to their complete identity in appearance. Yet at present this entire identity has been shown to have completely disappeared, and the smallest astronomical telescope will reveal the marked dissimilarity between the two. For not only is the one ring-plain considerably larger than the

other, but it is of different form and differently placed; one being roughly a circle foreshortened into an ellipse, with its apparent greater diameter from north to south; and the other being of an irregular form, foreshortened into a flattened oval, with its longest diameter nearly from east to west. Minor differences are also easily noticeable, and they cannot in any manner be considered to exactly resemble one another." Mr. Neison says (p. 506) "Gruithuisen in 1842 noticed that they were not exactly alike, but Webb was the first to point out the importance of this." The reader may see what Webb says in his "Cel. Objects," 3rd ed. p. 116, where he also gives a figure of Messier from a sketch taken in 1857, and pronounces that "we have here strong evidence of *modern physical change.*" On p. 507 we read, "It is noteworthy that while Mädler draws the two craters as exactly alike, Schröter draws the now smaller eastern (q. western?) as the larger of the two, a circumstance indicating a gradual change in its dimensions." . . . "Beer and Mädler, there cannot be the slightest question, on repeated occasions, paid particular attention to the relative dimensions and forms of these two craters; and the complete identity of the two in every respect they draw especial attention to, and as they themselves say, the slightest variation could not have escaped their notice. Had the two exhibited the now marked difference in form, it does not seem possible that it could have escaped the repeated and searching examinations of B. and M., so that there seems to have occurred in this formation a true modern physical change." That notwithstanding, the case of Messier has not been considered a clear proof of this, is thus explained by Mr. Neison: "It does not seem possible to conceive any admissible manner in which such a change could have been produced, though perhaps a more severe examination might reveal details of the greatest importance on this point. Here, however, as elsewhere, the greatest difficulty in the way of establishing instances of unquestionable lunar changes appears in the inability to show satisfactorily what the change is, even if it be admitted. And until the probable nature of the alteration has been shown, and until it has been established as one that may with probability be regarded as possible, it is not to be wondered that much reluctance should exist to admit it. Thus, until it can be shown with probability how on the moon a round ring-plain some miles in diameter can be squeezed into a contorted form, the difference now existing between the two ring-plains of Messier will not in general be held to establish an instance of actual change in a formation on the surface of the moon." We live in a severely critical, not to say sceptical age. Probably in the last century the reality of the change in Messier would have been unhesitatingly admitted. In favour of his supposed volcano, which was credited for a time, Herschel I. had no evidence like what has been shown in this case. And really we do not see how it can be rejected on purely *astronomical* grounds. Had it been a question of change in spots on Jupiter, or in the form of a nebula, no difficulty would have been felt. But our greater acquaintance with the moon seems to compel us to regard this as also a question of physics; which, if intractable by terrestrial analogy, causes to be regarded with distrust ever so many observations, however purposely and carefully made. Though even in this point of view we are not quite sure that certain conditions of contraction and subsidence may not go some way to explain the difficulty. It is not unlikely that cavities exist beneath the lunar surface, as in the earth, and the gradual sinking into one of them of a formation the exterior and interior of which may be supposed of different degrees of density and elasticity may perhaps account for the diminution of the western crater of Messier in size, and its alteration in form. But however

this may be, though "almost persuaded," if not quite, to believe in this change, in spite of the difficulty of accounting for it, we do not nevertheless feel great concern that as yet the transformation is not part of the creed of astronomers in general. In scientific matters scepticism is preferable to credulousness, and better still is often a suspended judgment. It is quite possible too, considering how vast a subject astronomy is now become, and the difficulty of bestowing much time and attention on more than a few of its branches, that there may be even eminent men who have never yet given fair and full place in their minds to this lunar question, so as to be able to form a definite judgment. Besides that, not all persons have quite what is called the courage of their opinions, and some prefer to wait before giving in their adherence to a view, until it becomes pretty generally received.

Variations also, apparently well established, in brightness and colour, both permanent and periodical, appear to indicate some "processes of weathering or tarnishing on the moon's surface." Of the former class, "the white spot within Werner may be taken as a typical instance; it consists of a small area about five miles square on the inner north-east wall. It was described by Mädler as a star-like glittering brilliant point, fully 10° bright, and therefore probably the brightest point on the entire moon. Now it is much fainter than this, and is surpassed in brilliancy by a number of other lunar formations. Considering the general faithfulness of the estimates of Mädler in this region, there exist good reasons for supposing that the brilliancy of this point has faded." In the class of periodical changes the variations on the floor of Plato may be instanced. "This formation is a ring-plain sixty miles in diameter, with a level interior containing a few small crater-cones. At sunrise the interior appears of the usual dull tint of the surface; it then quickly increases in brightness, in the same manner as the rest of the surface, for a short time; but then, instead of maintaining this bright appearance, commences to darken slowly, until at Full it is a dark steel grey, and forms one of the darkest points upon the entire moon. Soon afterwards it commences to grow gradually lighter, and passes through a somewhat similar variation, except that throughout the interior is somewhat darker. This change in brightness is not due to the effects of contrast, remaining unaffected when these are eliminated, and appears to be due to some special features on the floor. Beer and Mädler, with others, have also suggested the possibility of vegetation on the moon; but Mr. Neison thinks that although this is admissible, yet that hitherto little evidence has been found to connect in any way the periodical variations in tint with processes of vegetation. He concludes this chapter thus: "Much remains to be done in investigating the variations presented by different portions of the lunar surface, and it cannot be said at present that these have ever received the searching and systematic examination that they merit. For the purpose of thoroughly elucidating the present condition of the moon, this must be undertaken, and it cannot be properly carried out without leading to conclusions of the greatest importance and interest—not only with regard to the moon, but to the entire solar system."

The copious extracts embodied in our notice of this work have almost assumed the form and attained the dimensions of a little treatise. Before, however, we conclude, we will just for a moment digress from the subject of the moon itself to its influence on our own globe (and this not as to the weather and forms of madness, etc., though many still are believers in these things). "The moon," says Alexander Von Humboldt, "far more than all the other planetary bodies, diversifies and enlivens the aspect of the firmament in every zone by its varying phases and more rapid changes of

position relatively to the fixed stars; while man, and even the beasts of the forest (especially in the primeval forests of the torrid zone). rejoice in its mild lustre. By the attracting force which it exerts in conjunction with the sun, it communicates motion to our seas, and, by the periodical raising of their surfaces and the eroding action of the tides, gradually modifies the outlines of our coasts, impedes or favours man's labours, and furnishes the greater part of the materials of which sandstones and conglomerates are composed, these last being again covered in their turn by the loose rounded particles which form alluvium. Thus the moon, as one of the 'sources of movement' on the terrestrial surface, influences continually the geognostic features of our planet."

Enamoured of the beauty of Endymion, as the ancient myth has it, Selèna used to descend on Mount Latmos, in Caria, where he lay, sent to sleep by her, that she might be able to kiss him without being observed by him. (Many have, no doubt, admired a beautiful statue of him asleep in the British Museum). We fear Endymion was little of an astronomer. He must have missed some splendid opportunities, in which he would not have needed lenses or mirrors; and he might have learned something of the invisible side of his admirer. But he appears to have been the personification of that which the astronomer is so frequently obliged to forego—sleep—on which account, it may be, Riccioli assigned him a walled-plain in the moon, conspicuously dark, and not very far from the Lake of Dreams. He is by no means an example for selenographers. Rather should they take warning from him. Kissed by the soft rays of the Queen of Night, let them not give way to the influence that gently comes over one (expressed in the name *Endymion*), but with the best resources at their command patiently keep their silent watches. The beautiful object of their attention—for now she waits to be courted, and no more comes down to proffer her charms—will sooner or later reward their perseverance. A passion earnestly followed up cannot fail, in this case, to lead to interesting results. And here is something that will lighten their eyes; for whilst to the mere lunar dilettante (and we fear we are not much more ourselves) the volume we have been attempting to review will be a delightful and instructive companion by the side of his telescope, devoted and persistent moon-gazers will find it much more than that. An immense mass of well-arranged material as a basis for future exploration; fulness and accuracy of information; promising lines of research indicated; cautions, hints, and encouragements in observing, render it for them, what it will likely long remain, the best existing handbook and atlas of the moon; and for such a seasonable and laborious work they cannot fail to feel deeply indebted to its able and painstaking author.

Latitude and Longitude without Instruments, being a Chart for finding the hour of sunrise and sunset for every day in the year, at every place in the northern or southern hemisphere. By W. L. Yonge, Lieut.-Col. R.A. Letts, Son & Co., Limited, 8, Royal Exchange, London, E.C. (Indestructible copies of this chart may be had, printed on india-rubber, for pocket use when travelling.)

The main utility of this neat chart (about 14 in. by 18 in.) is for getting readily and sufficiently accurately the time of sunrise or sunset. It is not said whether refraction is allowed for, or whether it is the rising of the upper limb on the centre of the sun. "Latitude and Longitude without instruments" is scarcely a suitable title to place at the head, for the expectations of some may probably not be realized, and they may think the word of promise more kept to the ear than fulfilled to the hope. The arc of latitude is from 0° to 60° N. and S., clearly divided to quarters of degrees.

The latitude being known, the lines of sunrise and sunset may be obtained by simply placing a ruler on the chart as directed, to one or two minutes. Conversely, the latitude may be found when the line of sunrise or sunset is known, to about a quarter of a degree sometimes, though about the equinoxes the error might be considerably more. As for the longitude, a person is supposed to be in possession, by some means, of the local mean time, or to have obtained it by an observation of sunrise or sunset, after which he must compare it with a chronometer showing Greenwich time. This chart reminds us that 20 years ago, Mr. S. M. Saxby, R.N., invented the Spherograph ; two pieces of card-board, with circles of the sphere, revolving concentrically, by which all the problems of nautical astronomy—latitude, time, azimuth, altitude, and even clearing a lunar distance—can be quickly resolved with ease and accuracy. "It has been found by navigators that circles of 5 in. radius will work any question which arises at sea, sufficiently near for the practical purposes of the navigator. . . . The Spherograph is especially useful to check observations when worked out by logarithms." Perhaps some one of our readers could inform us where these instruments (for there are several adapted to various problems) are obtainable, as well as details of price, &c.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

SUSPECTED VARIABLE STAR (282).

Sir,—It may, perhaps, be worthy of passing note that the star referred to by Mr. Burnham in the August number of the *Astronomical Register*, No. 282 of his Fifth Catalogue of New Double Stars, is to be found in the Berlin Star Charts, viz :—in the overlap of Hour XVI. (Dr. Wolfers), and in Hour XVII. (Dr. Bremiker), it is marked of the 7th magnitude.

I am, sir, yours faithfully,

Cuckfield : GEORGE KNOTT.

September 7th, 1876.

THE SATELLITES OF SATURN.

Sir,—In June last when commencing in your pages for another season his valuable tables of the satellites of Saturn, Mr. Marth complained of the neglect by amateur observers of these predictions.

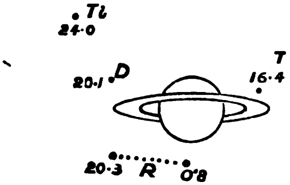
Judging by my own experience, one reason for this neglect may be the want of familiarity with the individuul satellites, and therefore an uncertainty as to the particular phenomenon to be expected. Finding considerable difficulty on this score, I ventured to appeal to Mr. Marth himself, and to ask his interpretation of rough sketches made on three consecutive nights. He was good enough to explain in reply how, from the data on page 227 of the September number of the *Register*, the semi-axes of the apparent ellipses, and the co-ordinates of the satellites, are to be obtained for any given time. And he added so excellent a suggestion that I take leave to transcribe it for the benefit of amateurs generally.

Mr. Marth says : "Instead of finding the places of the satellites by

computation, it will probably be simpler and yet sufficient, to lay down the apparent orbits graphically by drawing the ellipses with the semi-axes given on page 228, and then to estimate the places of the satellite roughly with the help of the times of conjunctions and greatest elongations, given on pp. 224—226.

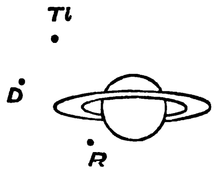
The method is both easy and effective. The apparent orbits and the planet being drawn to scale, the positions of the satellites for the times given can be readily marked on tracing-paper laid over the drawing, and the latter will no doubt be sufficiently accurate for at least a month, a fresh tracing being taken for each intended observation. For instance, the following sketch (Fig. 1) was made in this manner for the evening of the 18th instant, and Fig. 2 shows the configurations observed here on that day, at 22h. 30m. local sid. time [7m. 6·8sec. W. of Gr.]. Both figures are drawn as the telescope would show them.

FIG. 1



Predictions for the times stated.

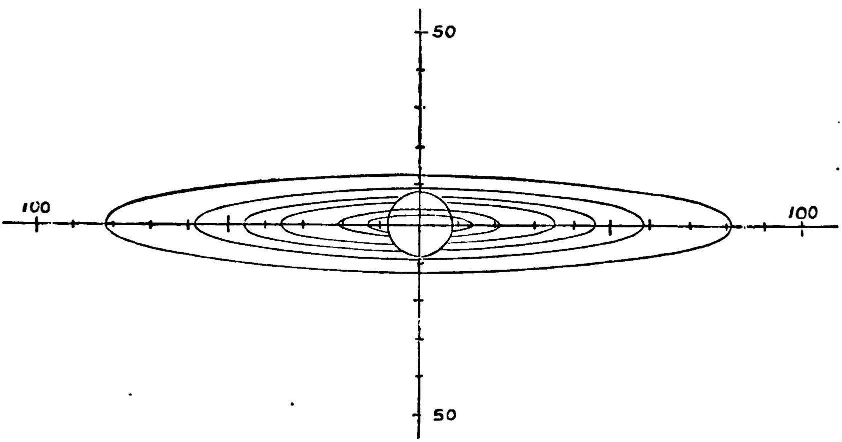
FIG. 2



Configurations at 22·30 S.T.

The scale is 50″ to the inch, the dimensions of Saturn being taken from the *Nautical Almanac*. Titan appeared to be in sp. conjunction about the time of observation. Tethys could not be seen. Below is a sketch which, if you can print it, may perhaps be useful, giving the planet and the orbits of four satellites for 1 Oct., derived from Mr. Marth's tables. Scale 1″ = 0·02 inch. The spaces of 10″ marked on rectangular co-ordinates through the centre of the planet, will give the positions of Titan and Iapetus, unless their elongations be too considerable. A slip of tracing-paper could be traced by the reader over the engraved or lithographic drawing, and the necessary indications marked in at once from next month's tables.

Apparent orbits of Enceladus, Tethys, Dione, and Rhea, for 1 *Oct*, 1876.



Mr. Marth's letter concluded thus: "The observations of real scientific value are the estimations of the true times of conjunctions there predicted. The question is, at what time does the perpendicular from the satellite upon the major axis of the ring hit exactly the end of the ring; or, as the estimation cannot be made directly, the question may be better put, between which two limits of time does the exact conjunction take place? At what minute does it become doubtful whether it is not close at hand, and at what minute is it no doubt past?"

Hatherop, Fairford: Yours faithfully,
19 Sept., 1876. THOS. S. BAZLEY.

OBSERVATION OF MINOR PLANET (165).

(From *Astronomische Nachrichten*, No. 2103).

Leipsic Mean Time.				R. A.			Decl.		
	h.	m.	s.	h.	m.	s.	°	′	″
Aug. 12	11	0	42	21	25	22·76	—10	1	45
	14	0	2			16·24			48
13	11	24	45	21	24	30·67	—10	2	22
	13	7	18			26·71			25
14	12	1	4	21	23	38·27	—10		34

Mag. 10·5.

C. BRUHNS.

DISCOVERY OF MINOR PLANET (166).

Washington, Planet (166). Discovered by Professor Peters at Clinton.
1867. August 10. R. A. 21h. 30m. Dec. — 19° 23′
Daily motion —10′ Mag. 11.

LUNAR OBJECTS SUITABLE FOR OBSERVATION IN OCTOBER, 1876.

By W. R. Birt, F.R.A.S., F.M.S.

In order to keep up the interest which has been manifested of late in the formation Fracastorius, attention will be directed this month to the southern part of the Mare Nectaris, immediately north of Fracastorius. Several drawings of Fracastorius have been received, in which the southern part of the Mare Nectaris is included. The tint of the surface of this part of the Mare under high illumination is dark, but not so dark as the floor of Plato, and the most conspicuous object on it is the Crater Rosse (Neison Map XXII). In Neison's work this crater is described as possessing walls of 7° of brightness, the interior being as much as 6°; it would be well to compare its brightness with that of neighbouring craters, especially as variations in brightness have been suspected in several lunar objects: it is also described as a point at which two light streaks traversing the Mare cross. In one of the drawings dated August 6, 1.15 a m., sent to me by Mr. Dennett, these streaks are given crossing at Rosse, and in a drawing by Simms, dated August 8th, a portion of one extending from the western wall of Fracastorius to Rosse is given. Mr. Simms marks the Mare on the western side of this streak at a *higher* level than the Mare on the eastern. A careful scrutiny will show that the southern part of the Mare Nectaris is crossed by a "ray" from

the bright Crater II. See *Astronomical Register*, April, 1876, p. 97, and also one in nearly the same direction from Rosse: observations are needed to determine the *form* and *brilliancy* of these rays, which lie in the direction of a grand "ray from Tycho"; they are symbolized, the one from Rosse by IV. B. ρ 10, and that from Crater II. by IV. B. ρ 11. The streak or ridge from the west border of Fracastorius to Rosse also requires careful attention, the drawings of it in my possession not being accordant.

Neison mentions three deep craters south of Rosse, which he marks *a*, *b* and *c*. Of these Simms gives *b*, which he marks 12 (see *English Mechanic*, No. 589, p. 432, letter 11,161). These craters are in B. and M.'s. Map. Neison also gives another crater which aligns with Rosse, *b*, and a mountain on the nothern floor of Fracastorius undesignated by him. This mountain I apprehend to be XII. of the Synopsis of which numbers I. to XI. have been given in the *Register* for April, June and August.

XII. A low mountain with three peaks, first seen by me on September 13, 1862, also in 1863 and 1865, July 11, when I recorded a depression or dimple on the S.W. part of its surface. Grover saw it in the same year on July 1. In 1870 Elger drew and described it as a very remarkable formation, rising above the general level of the floor of Fracastorius, the north and east borders straight and sharply defined. Birmingham, in November, 1870, and also on January 10, 1871, gave the three peaks with a craterlet enclosed by them. Ingall saw it on the morning of July 17, 1870, when it was observed to terminate the eastern line of eruption on the floor of Fracastorius. It was probably seen by the Rev. J. B. Richards on April 28, 1876. The pecularity of form noticed by Elger in 1870 has lately been confirmed by Simms and Dennett during the early part of August, 1876.

Erratum.—September, page 200, line 1, for *Bird* read *Birt.*

THE ARCETRI OBSERVATORY.

We find the following in a recent Italian paper:—

"One of the best observatories of the kingdom is certainly that of Arcetri. After the death of Prof. Donati the direction of the observatory was entrusted to Prof. Tempel, a German, who had before been associated in the observatory with the late distinguished and lamented astronomer. Prof. Tempel, to whom the science is indebted for the discovery of new groups of nebulæ, is at present busily engaged on a new chart of the moon, in which will appear divers new craters recently discovered by him. It is an important work, from which the cultivators of astronomy will derive great advantage. Prof. Tempel is well known for the extreme courtesy with which he receives all who desire to view the starry heavens with the famous telescope of Amici. At the first quarter of the moon when our satellite is best placed for observation, there is always a great concourse of the public, and Prof. Tempel is most ready to afford every explanation even to the least instructed. But in the absence of the moon he must on no account be interfered with; for then he is occupied in the observation of his beloved nebulæ, anxious to increase the patrimony of the science by some discovery of importance. During the daytime he works at his fine chart of the moon, which he is in hopes of finishing very shortly. We shall recur to it then; and meanwhile desire that the labours of the distinguished Professor may not fail to be appreciated as they justly deserve."

ASTRONOMICAL OCCURRENCES FOR OCTOBER, 1876.

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. Saturn.
Sun	1	7 30 8 2	Occultation of B.A.C. 8184 (5½) Reappearance of ditto			9 36·1
Mon	2	22 56	○ Full Moon Saturn's Ring: Major axis=42″·00 Minor axis=6″·53			9 32·0
Tues	3		Sidereal Time at Mean Noon, 12h. 50m. 7·59s.	1st Tr. I. 1st Sh. I.	6 16 7 14	9 27·8
Wed	4		Sun's Meridian Passage 11m. 26·24s. before Mean Noon	2nd Tr. I. 1st Ec. R.	6 18 6 35 14	6 23·7
Thur	5	14 44 15 21 16 19	Near approach of 47 Arietis (6) Occultation of ε Arietis (4½) Reappearance of ditto			9 19·6
Fri	6	5 39 6 20 9 10 9 58 9 12 9 39 9 39 10 34 10 30 11 6 10 45	Occultation of 17 Tauri (4) Reappearance of ditto Occultation of 23 Tauri (5) Reappearance of ditto Near approach of 16 Tauri (5½) Near approach of 20 Tauri (5) Occultation of η Tauri (3) Reappearance of ditto Occultation of 28 Tauri (5½) Reappearance of ditto Near approach of 27 Tauri (4)	2nd Ec. R.	5 48 7	9 15·5
Sat	7					9 11·4
Sun	8	10 21	Near approach of 136 Tauri (5)	3rd Oc. R.	5 42	9 7·3
Mon	9	22 19 15 44 16 58	☾ Moon's Last Quarter Occultation of 47 Geminorum (6) Reappearance of ditto			9 3·2
Tues	10					8 59·1
Wed	11			1st Oc. D.	5 27	8 55·0
Thur	12	18	Inferior conjunction of Mercury and Sun	1st Sh. E.	5 51	8 50·9
Fri	13	8	Conjunction of Moon and Venus 1° 16′ S.			8 46·8

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Sat	14					8 42·8
Sun	15	6	Conjunction of Moon and Mars 2° 28′ N. Illuminated portion of disc of Venus=0·612 Illuminated portion of disc of Mars=0·988			8 38·7
Mon	16	21 57 9	● New Moon Conjunction of Moon and Mercury 2° 14′ N.			8 34·7
Tues	17		Sidereal Time at Mean Noon 13h. 45m. 19·35s.			8 30·6
Wed	18		Sun's Meridian Passage 14m. 53·05s. before Mean Noon			8 26·6
Thur	19			1st Sh. I.	5 33	8 22·5
Fri	20	0	Conjunction of Moon and Jupiter 5° 40′ N.	1st Ec. R.	4 53 4	8 18·5
Sat	21					8 14·5
Sun	22		Saturn's Ring: Major axis=40″·89 Minor axis=6″·58	2nd Sh. E.	5 20	8 10·4
Mon	23					8 6·4
Tues	24	19 54	☽ Moon's First Quarter			8 2·4
Wed	25					7 58·4
Thur	26	11	Opposition of Neptune and Sun	3rd Sh. I.	4 59	7 54·4
Fri	27	12 30 6	Near approach of 58 Aquarii (6) Conjunction of Moon and Saturn 0° 17′ S.			7 50·4
Sat	28	9 45 10 46 13 17 14 10	Occultation of φ Aquairi (4½) Reappearance of ditto Occultation of 96 Aquarii (5½) Reappearance of ditto			7 46·5
Sun	29			2nd Sh. I.	5 15	7 42·5
Mon	30	10 27 11 39	Occultation of 60 Piscium (6) Reappearance of ditto			7 38·5
Tues	31					7 34·6
NOV. Wed	1	12 9 13 21	Occultation of B.A.C. 782 (6½) Reappearance of ditto			7 30·6

THE PLANETS FOR OCTOBER.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	13 42 59	S. 14 33	8″·8	1 0·6
	9th	13 27 5	S. 11 59½	10″·0	0 13·3
	17th	12 55 12	S. 5 42	9″·2	23 6·1
	25th	12 58 57	S. 4 13	7″·2	22 38·4
Venus ...	1st	9 42 36	N. 12 49	21″·6	20 56·9
	9th	10 16 7	N. 10 34½	20″·0	20 58·9
	17th	10 50 7	N. 7 55	18″·6	21 1·3
	25th	11 24 25	N. 4 56	17″·6	21 4·1
Saturn ...	1st	22 19 54	S. 12 23½	16″·8	9 36·1
	9th	22 18 26	S. 12 31	16″·6	9 3·2
	17th	22 17 20	S. 12 37	16″·6	8 30·6
	25th	22 16 36	S. 12 40	16″·4	7 58·4
Neptune ...	3rd	2 11 30	N. 11 19	...	13 19·2
	19th	2 9 52	N. 11 10	...	12 14·7

Mercury may be observed in the morning from the middle of the month, rising on the 17th three-quarters of an hour before the sun, the interval increasing.

Venus rises about two hours after midnight on the 1st, the interval increasing.

Saturn is visible till two hours and a half after midnight, at the beginning of the month, the interval decreasing. His southern declination is still unfavourable for observation.

Neptune will be in opposition to the sun on the 26th.

SATELLITES OF SATURN.

Approximate Greenwich sidereal times of conjunctions and elongations occurring between 18h. and 6h. Greenwich sidereal time.

f. conj. with following edge of ring.	n. north of ring.
p. " " preceding " "	s. south "
sup. superior conj. with centre of ball.	e. at greatest eastern elongation.
inf. inferior " "	w. " western "

1876.		Gr. Sid. Time. h.		
Oct.	1	18·3	Encel.	nf.
		22·3	Tethys.	sf.
		23·4	Encel.	e.
		4·4	Encel.	sf.
		4·8	Mimas.	e.
		5·3	Tethys.	sp.
		5·6	Dione.	sf.
	2	19·2	Rhea.	nf.
		20·9	Encel.	np.
		21·0	Tethys.	np.
		1·9	Dione.	w.
		3·3	Encel.	nf.
		3·5	Mimas.	e.

1876.		Gr. Sid. Time. h.		
		4·0	Tethys.	nf.
	3	19·8	Encel.	sp.
		19·8	Tethys.	sf.
		22·2	Dione.	nf.
		0·8	Encel.	w.
		2·2	Mimas.	e.
		2·7	Tethys.	sp.
		5·9	Encel.	np.
	4	14·1	Titan.	inf. 29″ s.
		18·5	Tethys.	np.
		21·0	Rhea.	inf. 13″ s.
		22·3	Encel.	sf.
		23·4	Dione.	sf.

1876.	Gr. Sid. Time. h.		
Oct. 4	0·9	Mimas.	e.
	1·4	Tethys.	nf.
	1·6	Rhea.	sp.
	3·3	Dione.	inf. 9″ s.
	4·7	Encel.	sp.
5	19·7	Dione.	w.
	21·2	Encel.	nf.
	23·5	Mimas.	e.
	0·1	Tethys.	sp.
	0·2	Rhea.	w.
	2·3	Encel.	e.
6	18·8	Encel.	w.
	22·2	Mimas.	e.
	22·8	Tethys.	nf.
	22·9	Rhea.	np.
	23·8	Encel.	np.
	3·3	Rhea.	sup. 13″ n.
	4·7	Dione.	e.
7	20·9	Mimas.	e.
	21·1	Dione.	inf. 9″ s.
	21·5	Tethys.	sp.
	22·7	Encel.	sp.
	1·0	Dione.	sp.
	3·7	Encel.	w.
	5·4	Tethys.	w.
8	19·6	Mimas.	e.
	20·2	Encel.	e.
	20·3	Tethys.	nf.
	1·3	Encel.	sf.
	2·2	Dione.	np.
	4·1	Tethys.	e.
	5·2	Rhea.	sf.
9	18·3	Mimas.	e.
	19·0	Tethys.	sp.
	22·5	Dione.	e.
	0·1	Encel.	nf.
	2·9	Tethys.	w.
	5·2	Encel.	e.
	5·6	Mimas.	w.
10	18·8	Dione.	sp.
	21·7	Encel.	w.
	1·6	Tethys.	e.
	2·7	Encel.	np.
	4·3	Mimas.	w.
11	19·2	Encel.	sf.
	20·0	Dione.	np.
	20·6	Rhea.	nf.
	0·3	Tethys.	w.
	1·6	Encel.	sp.
	3·0	Mimas.	w.
	3·8	Dione.	nf.
	7·2	Titan.	sup. 29″ n.
12	18·1	Encel.	nf.
	19·2	Rhea.	e.

1876.	Gr. Sid. Time. h.		
Oct. 12	23·0	Tethys.	e.
	23·1	Encel.	e.
	1·6	Mimas.	w.
	4·2	Encel.	sf.
	5·0	Dione.	sf.
13	20·7	Encel.	np.
	21·7	Tethys.	w.
	22·4	Rhea.	inf. 13″ s.
	0·3	Mimas.	w.
	1·3	Dione.	w.
	2·9	Rhea.	sp.
	3·1	Encel.	nf.
	5·6	Tethys	np.
14	19·5	Encel.	sp.
	20·4	Tethys.	e.
	21·6	Dione.	nf.
	23·0	Mimas.	w.
	0·6	Encel.	w.
	1·6	Rhea.	w.
	4·3	Tethys.	sf.
	5·6	Encel.	np.
15	19·1	Tethys.	w.
	21·7	Mimas.	w.
	22·1	Encel.	sf.
	22·8	Dione.	sf.
	0·2	Rhea.	np.
	2·7	Dione.	inf. 9″ s.
	3·0	Tethys.	np.
	4·5	Encel.	sp.
	4·7	Rhea.	sup. 13″ n.
16	19·1	Dione.	w.
	20·4	Mimas.	w.
	21·0	Encel.	nf.
	1·7	Tethys.	sf.
	2·1	Encel.	e.
17	18·5	Encel.	w.
	19·0	Mimas.	w.
	23·6	Encel.	np.
	0·5	Tethys.	np.
	4·1	Dione.	e.
	6·0	Encel.	nf.
18	20·5	Dione.	inf. 9″ s.
	22·5	Encel.	sp.
	23·2	Tethys.	sf.
	0·4	Dione.	sp.
	3·5	Encel.	w.
	5·1	Mimas.	e.
19	20·0	Encel.	e.
	21·9	Tethys.	np.
	1·1	Encel.	sf.
	1·6	Dione.	np.
	3·7	Mimas.	e.
	4·8	Tethys.	nf.
	13·3	Titan.	inf. 29″ s.

1876.	Gr. Sid. Time. h		
Oct. 20	20·6	Tethys.	sf.
	21·9	Dione.	e.
	21·9	Rhea.	nf.
	23·9	Encel.	nf.
	2·4	Mimas.	e.
	3·5	Tethys.	sp.
	5·0	Encel.	e.
21	18·3	Dione.	sp.
	19·3	Tethys.	np.
	20·6	Rhea.	e.
	21·5	Encel.	w.
	1·1	Mimas.	e.
?	1·4	Conj. of Iapetus with following edge of ring, 14″ n.	
	2·2	Tethys.	nf.
	2·5	Encel.	np.
?	13·5	Iapetus. inf. 10″ n.	
22	18.0	Tethys.	sf.
	19·0	Encel.	sf.
	19·2	Rhea.	sf.
	19·5	Dione.	np.
	23·8	Rhea.	inf. 13″ s.
	23·8	Mimas.	e.
	1·0	Tethys.	sp.
	1·4	Encel.	sp.
?	1·6	Conj. of Iapetus with preceding edge of ring, 6″ n.	
	3·2	Dione.	nf.
	4·3	Rhea.	sp.
23	22·5	Mimas.	e.
	22·9	Encel.	e.
	23·7	Tethys.	nf.
	2·9	Rhea.	w.
	4·0	Encel.	sf.
	4·4	Dione.	sf.
24	20·5	Encel.	np.
	21·1	Mimas.	e.
	22.4	Tethys.	sp.
	0·7	Dione.	w.
	1·6	Rhea.	np.
	2·9	Encel.	nf.
	6·1	Rhea.	sup. 13″ n.
25	19·3	Encel.	sp.
	19·8	Mimas.	e.
	21·1	Dione.	nf.
	21·1	Tethys.	nf.
	0·4	Encel.	w.
	5·0	Tethys.	e.
	5·4	Encel.	np.
26	18·5	Mimas.	e.

1876.	Gr. Sid. Time. h		
Oct. 26	19·8	Tethys.	sp.
	21·9	Encel.	sf.
	22·3	Dione.	sf.
	2·1	Dione.	inf. 9″ s.
	3·7	Tethys.	w.
	4·3	Encel.	sp.
	5·8	Mimas.	w.
	6·0	Dione.	np.
27	18·5	Tethys.	nf.
	18·6	Dione.	w.
	20·8	Encel.	nf.
	20·9	Moon near.	
	1·9	Encel.	e.
	2·4	Tethys.	e.
	4·5	Mimas.	w.
	6·6	Titan. sup. 28″ n.	
28	18·3	Encel.	w.
	23·4	Encel.	np.
	1·1	Tethys.	w.
	3·2	Mimas.	w.
	3.5	Dione.	e.
	5·8	Encel.	nf.
29	18·8	Rhea. sup. 13″ n.	
	20·0	Dione inf. 9″ s.	
	22·3	Encel.	sp.
	23·3	Rhea.	nf.
	23·9	Tethys.	e.
	23·9	Dione	sp.
	1·9	Mimas.	w.
	3·3	Encel.	w.
30	19·8	Encel.	e.
	22·0	Rhea.	e.
	22·6	Tethys.	w.
	0·6	Mimas.	w.
	0·9	Encel.	sf.
	1.1	Dione.	np.
31	20·7	Rhea.	sf.
	21·3	Tethys.	e.
	21·4	Dione.	e.
	23·2	Mimas.	w.
	23·7	Encel.	nf.
	1·2	Rhea.	inf. 13″ s.
	4·8	Encel.	e.
	5·2	Tethys.	sf.
	5·7	Rhea.	sp.
Nov. 1	20·0	Tethys.	w.
	21·3	Encel.	w.
	21·9	Mimas.	w.
	2·3	Encel.	np.
	3·9	Tethys.	np.
	4·4	Rhea.	w.

Elongations of the five inner satellites at oh. Gr. Sid. Time of every fifth day.

1876.	Mimas.		Encel.		Tethys.		Dione.		Rhea.	
	l.	diff.	l.	diff.	l.	diff.	l.	diff.	l.	diff.
Oct.	°	°	°	°	°	°	°	°	°	°
2	34·3	1904·9	359·0	1310·2	355·9	951·0	259·6	656·1	30·8	397·5
7	139·2	·8	229·2	·2	226·9	·0	195·7	·0	68·3	·5
12	244·0	·8	99·4	·1	97·9	951·0	131·7	656·0	105·8	·5
17	348·8	·7	329·5	·1	328·9	950·9	67·7	655·9	143·3	·5
22	93·5	·7	199·6	·1	199·8	·9	3·6	·9	180·8	·4
27	198·2	1904·6	69·7	1310·0	70·7	950·9	299·5	655·9	218·2	397·4
Nov.										
1	302·8		299·7		301·6		235·4		255·6	

To find the elongations for some given hour, the corresponding portions of the differences, "diff." must be added to the values of l. given in the table, or as the differences refer to 5 sidereal days, or 120 hours, the quantities "$\frac{\text{diff.}}{120}$ × number of hours" elapsed since oh. of the day, for which the l. are given, must be added (subtracting 360° or its multiples, in case the sums are larger). These quantities may be taken from page 227.

The rectangular co-ordinates x″, y″ of the satellites, reckoned parallel to the axes of the ring, are then found by $x'' = a \sin l$, and $y'' = b \cos l$, and the polar co-ordinates p and s by

$$s \sin (p - 6°{\cdot}3) = a \sin l.$$
$$s \cos (p - 6°{\cdot}3) = b \cos l.$$

where a and b, the semi-axes of the apparent orbits, may be taken from the following table, the last columns of which contain the hourly changes of the co-ordinates of fixed stars in reference to the axes of the ring.

	Mimas.		Encel.		Tethys.		Dione.		Rhea.		Hourly change.	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	of *x*″	of *y*″
Oct.	″	″	″	″	″	″	″	″	″	″	″	″
2	28·6	4·5	35·9	5·6	45·5	7·1	58·2	9·1	81·3	12·7	+6·9	+3·4
7	28·4	4·5	35·7	5·6	45·2	7·1	57·9	9·1	80·8	12·7	6·0	2·9
12	28·2	4·5	35·4	5·6	44·9	7·1	57·5	9·2	80·3	12·8	5·1	2·4
17	28·0	4·5	35·2	5·6	44·6	7.1	57·1	9·2	79·8	12·8	4·1	1·8
22	27·8	4·5	34·9	5·6	44·2	7·1	56·7	9·1	79·2	12·8	3·0	1·2
27	27·6	4·5	34·7	5·6	43·9	7·1	56·2	9·1	78·6	12·7	1·9	0·7
Nov.												
1	27·4	4·4	34·4	5·6	43·5	7·1	55·8	9·0	77·9	12·6	+0·8	+0·1

Approximate places of the inner satellites may be found more readily and without any computation with logarithms, by means of the following tables, the first of which gives again the elongation l. for oh. Gr. Sid. T. of every fifth day, but expressed, not in degrees, but in decimal fractions of a revolution.

oh. Gr. Sid. T.

	Mimas.		Encel.		Tethys.		Dione.		Rhea.	
Oct.	l.	diff.	l.	diff.	l.	diff.	l.	diff.	l.	diff.
2	·095	5·292	·997	3·640	·989	2·641	·721	1·823	·085	1·105
7	·387	5·291	·637	3·639	·630	2·642	·544	1·822	·190	1·104
12	·678	5·291	·276	„	·272	2·642	·366	„	·294	„
17	·969	5.291	·915	„	·914	2·641	·188	„	·398	„
22	·260	5·290	·554	„	·555	2·641	·010	„	·502	„
27	·550	5·290	·193	3·639	·196	2·642	·832	1·822	·606	1·104
Nov.										
1	·840		·832		·838		·654		·710	

These values must be interpolated for the times for which the places of the satellites are required or to the given values of l. must be added "$\frac{\text{diff.}}{120}$ × number of hours elapsed since the previous tabular date." The corresponding quantities for the even hours between 20h. and 4h. Gr. Sid. T. may be taken from the following table :—

	Mimas.	Encel.	Tethys.	Dione.	Rhea.
On the tabular date—					
h.	°	°	°	°	°
At 20	·824	·879	·912	·939	·963
22	·912	·939	·956	·970	·982
0	·000	·000	·000	·000	·000
2	·088	·061	·044	·030	·018
4	·176	·121	·088	·061	·037
On the first intermediate day—					
At 20	·882	·607	·440	·304	·184
22	·970	·667	·484	·334	·202
0	·058	·728	·528	·364	·221
2	·146	·789	·572	·395	·239
4	·235	·849	·616	·425	·257
On the second intermediate day—					
At 20	·940	·335	·969	·668	·405
22	·028	·395	·013	·698	·423
0	·117	·456	·057	·729	·441
2	·205	·517	·101	·759	·460
4	·293	·577	·145	·790	·478
On the third intermediate day—					
At 20	·998	·063	·497	·033	·625
22	·087	·123	·541	·063	·644
0	·175	·184	·585	·093	·662
2	·263	·244	·629	·124	·680
4	·351	·305	·673	·154	·699
On the fourth intermediate day—					
At 20	·057	·791	·025	·397	·846
22	·145	·851	·069	·427	·864
0	·233	·912	·113	·458	·883
2	·322	·973	·157	·488	·901
4	·410	·033	·201	·519	·919

The elongations l. having been found by adding these quantities to the values of l. for 0h. of the tabular date (subtracting 1, in case the sum is larger), the co-ordinate s, expressed in semi-diameters of the planet's equator, is to be taken with the argument l. from the following table :—

l.	l.	Mimas.	Encel.	Tethys.	Dione.	Rhea.	l.	l.
·000	·500	0·0	0·0	0·0	0·0	0·0	·500	·000
·010	·490	0·2	0·3	0·3	0·4	0·6	·510	·990
·020	·480	0·4	0·5	0·6	0·8	1·1	·520	·980
·030	·470	0·6	0·8	0·9	1·2	1·7	·530	·970
·040	·460	0·8	1·0	1·2	1·6	2·2	·540	·960
·050	·450	1·0	1·2	1·5	2·0	2·8	·550	·950
·060	·440	1·2	1·5	1·8	2·4	3·3	·560	·940
·070	·430	1·3	1·7	2·1	2·7	3·8	·570	·930
·080	·420	1·5	1·9	2·4	3·1	4·3	·580	·920
·090	·410	1·7	2·2	2·7	3·4	4·8	·590	·910
·100	·400	1·8	2·4	2·9	3·8	5·3	·600	·900
·110	·390	2·0	2·6	3·2	4·1	5·7	·610	·890

·120	·380	2·2	2·8	3·4	4·4	6·1	·620	·880
·130	·370	2·3	2·9	3·6	4·7	6·5	·630	·870
·140	·360	2·4	3·1	3·8	4·9	6·9	·640	·860
·150	·350	2·5	3·3	4·0	5·2	7·2	·650	·850
·160	·340	2·7	3·4	4·2	5·4	7·5	·660	·840
·170	·330	2·8	3·5	4·4	5·6	7·8	·670	·830
·180	·320	2·8	3·6	4·5	5·8	8·1	·680	·820
·190	·310	2·9	3·7	4·6	5·9	8·3	·690	·810
·200	·300	3·0	3·8	4·7	6·1	8·5	·700	·800
·210	·290	3·0	3·9	4·8	6·2	8·7	·710	·790
·220	·280	3·1	4·0	4·9	6·3	8·8	·720	·780
·230	·270	3·1	4·0	5·0	6·3	8·9	·730	·770
·240	·260	3·1	4·0	5·0	6·4	8·9	·740	·760
·250	·250	3·1	4·0	5·0	6·4	8·9	·750	·750
nf.	sf.						sp.	np.

If l. is between ·000 and ·025 the satellite is on the following side, n. of ring.
·025 „ ·050 „ „ „ „ s. „
·050 „ ·075 „ „ preceding „ s. „
·075 „ ·000 „ „ „ „ n. „

If only a general notion of the places of the satellites is required, it may, perhaps, be procured in the simplest way by laying down the apparent orbits graphically, and by estimating the positions of the satellites with the help of the known times of the conjunctions and greatest elongations. (A complete list of them has been published in No. 2,098—2,100 of the *Astronomische Nachrichten*, while in the *Astronomical Register* only those occurring between 18h. and 6h. Gr. Sid. T. are given, as the whole list would occupy double the space). The semi-axes of the apparent orbits of the five inner satellites, expressed in semi-diameters of the ball's equator, may be taken to be

	Mimas.	Encel.	Tethys.	Dione.	Rhea.
Semi-major axis	3·14	4·03	4·99	6·40	8·93
Semi-minor „	0·50	0·64	0·79	1·01	1·41

If then the distances from the centre of the major-axes are marked 3, 4, 5, &c., Enceladus will be opposite the point 3 about 3·8 hours before and after its greatest elongation,

				h.	
Tethys	opposite point	3	about	1·2	*Before* the conjunctions with the ends of the ring, marked "np." and "sf." and *After* the conjunctions marked "nf." and "sp." in the list.
		4	„	3·2	
Dione	„ „	3	„	1·3	
		4	„	3·2	
		5	„	5·5	
Rhea	„ „	3	„	1·4	
		4	„	3·5	
		5	„	5·8	
		6	„	8.2	
		7	„	11·1	
		7	„	11·6	Before & after its greatest elong.
		8	„	8·0	„ „ „
Dione	„ „	6	„	3·7	„ „ „

Differences of right ascension and declination of Titan and Iapetus and of the centre of Saturn. At 0h. Gr. Sider. Time.

		Titan.		Iapetus.	
		α—A.	δ—D.	α—A.	δ—D.
1876.		s.	"	s.	"
Oct.	1	+10·81	—32·6	+37·07	+24·9
	2	7·26	35·4	37·09	25·7
	3	+2·70	33·1	36·87	26·4

Oct.	4	—2·25	26·0	36·42	26·8
	5	6·84	15·1	35·73	27·0
	6	10·36	—1·8	34·81	27·1
	7	12·21	+11·8	33·67	26·9
	8	12·05	23·5	32·32	26·6
	9	9·89	31·4	30·77	26·2
	10	6·09	33·8	29·04	25·5
	11	—1·29	30·8	27·13	24·7
	12	+3·70	23·0	25·05	23.8
	13	8·10	+11·5	22·83	22·7
	14	11·29	— 1.7	20·48	21·5
	15	12·83	14·6	18·01	20·2
	16	12.53	25·5	15·45	18·7
	17	10.48	32·7	12·79	17·2
	18	6·96	35·4	10·07	15·6
	19	+2·46	33·1	7·30	13·9
	20	—2·38	25·9	4·49	12·1
	21	6·84	14·9	+ 1·67	10·3
	22	10·23	—1·6	—1·15	8·4
	23	11·97	+11·9	3·96	6·6
	24	11·75	23·5	6·74	4·7
	25	9·58	31·1	9·46	2·8
	26	5·83	33·5	12·12	+0·8
	27	—1·13	30·5	14·70	—1·1
	28	+3·73	22·6	17·19	2·9
	29	8·01	+11·2	19·57	4·8
	30	11·07	—1·8	21·83	6·6
	31	12·53	14·5	23·96	8·3
Nov.	1	+12·20	—25·2	—25·94	+10·0

It would be of considerable importance for the investigation of the motions of Iapetus, if the conjunctions of the satellite with the ends of the ring on October 21 and 22 were carefully observed. No such observation has ever been made.

66, Lambeth Road, S.E. A. M.

Book Received.—"Seventh Catalogue of Double Stars." By S. W. Burnham

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ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

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To March, 1877.
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To Oct., 1877.
Morris, E. R.

To Dec., 1877.
Rylands, T. G.

To June, 1879.
Loder, E. G.

TO CORRESPONDENTS.

Several interesting articles are unavoidably postponed.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

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The Astronomical Register.

No. 167. NOVEMBER. 1876.

PROGRESS OF ASTRONOMY, 1865 to 1875.

Dr. Neumann in a lecture delivered in Dresden summarised the later astronomical discoveries as follows (we merely give an abstract):—*Solar Physics.* The discoveries in this department of astronomy amounted to as many as 25 by Carrington, Howlett, Weiss, Spörer, Secchi, Janssen, Herschel, Zollner and Tacchini. Carrington's discoveries were mainly of drift, the direction being contrary to that of the sun's rotation; the division of spots by a whirling motion of their parts; regions of sun-spots and faculæ, and bands vacant of sun-spots. Howlett and Weiss observed the moving away of some dark spots over others. Spörer and Secchi found that spots occur over brighter surfaces, and also that the various shadings of the nuclei are simply due to the fact that the brighter surface beneath comes out more or less. Even the darkest nuclei appear with strong magnifications, torn and crossed by fine lines of light. Janssen and Herschel, from observations made during the total eclipse of the sun on August 15, 1868, determined that the protuberances belong to the sun and are of a gaseous nature. The principal result of Janssen's discovery that the protuberances can be observed at any time with the spectroscope are as under: "The protuberances change with great rapidity and can even be observed where there is much accumulation in front of the sun's disc." "The entire sun is surrounded by an envelope of gas 8,000 to 12,000 kilometres in height,

Bacon (M.) Roger Bacon (?), 1255.
Bailly (S.) French astron., d. 1793 (executed).
Baily (M.) English astron., d. 1844.
Ball (B.) English astron., 17th century.
Barrow (M.) English math., d. 1677.
Bayer. German astron., d. 1625.
Beaumont (M.) Q. Elie de Beaumont, French geologist (?)
Behaim (M.) Behem, German navigator and astron., d. 1506.
Bernouilli (S.) Jas. B. Basel, math., d. 1705; John B., his brother, math., d. 1748; Dan. B., son of John, d. 1782. (Eight math. in this family.)
Berosus. Priest of Belus in Babylon, historian, cir. 250 B.C.
Berzelius (M.) Swedish chemist, d. 1848.
Bessarion. Cardinal, d. 1472.
Bianchini (S.) Italian math., astron., and antiquar., d. 1729.
Billy. French astron., d. 1679.
Blancanus. Biancani, math. of Bologna, d. 1624.
Blanchinus (S.) Q. Can this be the same as Bianchini and twice named?
Boguslawsky (M.) Astron., d. 1851.
Bohnenberger (M.)
Bonpland (M.) Botanist, travelled with A. von Humboldt.
Borda (M.) Fr. math. and astron., d. 1799.
Boscovich (M.) Italian math. and astron. d. 1787.
Bouguer (S.) Fr. math. d. 1758.
Boussingault (M.) Nat. Philos., friend of A. von Humboldt.
Buch (M.) Prussian geologist, d. 1853.
Bullialdus. Fr. astron. and math. (Bouillaud), d. 1694.
Burckhardt (M.) Germ. astron., d. 1825.
Burg (M.) Germ. astron., d. 1834.
Byrgius. Byrge, math. and astron., d. 1633, at Hesse-Cassel.
Explanation of the following names wanted: Barocius (R.), Bettinus (R.), Büsching (M.)

Calippus. Of Cyzicus, cir. B.C. 320. ("Calippic period.")
Campanus. Q. Italian, first translator of Euclid from Arabic, 11th century?
Capella. Latin writer on many subjects, 5th century.
Cardanus. Ital. math., d. 1576.
Casatus. Ital. math. (Casati), d. 1707.
Catharina. Called after one of the canonized persons of that name?
Cavalerius. (Cavalieri) Ital. math., pupil of Galileo, and friend of Riccioli, d. 1647.
Censorinus. Writer on astrology, chronology, &c. (De die Natali), d. A.D. 238.
Cepheus. King of Æthiopia, husband of Cassiopeia, and father of Andromeda.
Christian Mayer (S.) Germ. astron., d. 1783.
Clausius (N.) Physicist and math., 19th century.
Clavius. Germ. math,, d. 1612.
Cleomedes. Gr. math., 2nd century A.D. (?)
Cleostratus. Of Tenedos, cir. 500 B.C.
Conon. Of Alexandria, friend of Archimedes.
Crisium Mare. Sea of Crises (critical days, or the turnings of diseases).
Curtius. Q. Q. Curtius the historian. (?)
Cyrillus. Astron. Alexandrian school.

Explanation of the following names wanted: Cabeus (R.), Capuanus (R.), Cichus (R.), Crüger (R.), Cysatus (R.)

Daniell (B.) Prof. of chemistry and meteorology, d. 1845.
Democritus. Gr. philos., d. B.C. 357.
Delisle (S.) Fr. astron., d. 1768.
Deluc (M.) Genevese geologist, &c., d. 1817.
Dionysius. Periegétes? Geograph. poem, 3rd or 4th century, A.D.
Diophantus (M.) Of Alexandria, algebraist, period uncertain.
Dörfel Mts. (S.) Astron. of Saxony, d. 1680.
Doppelmayer (S.) Germ. math., d. 1750.
Drebbel (M.) Dutch chemist, d. 1634.

Egede (M.) Danish missionary to Greenland, d. 1758.
Endymion. Mythol. person.
Epigenes. Of Byzantium, date uncertain.
Eratosthenes. Astron. and geogr., Alex. school, 3rd century B.C.
Euctemon. Gr. astron., contemp. with Meton.
Eudoxus. Of Cnidus., astron., cir. B.C. 370.
Explanation of the following wanted: Eichstädt (R.), Eimmart (S.).

Fabricius. David F., Germ. astron., d. 1617. John F., his son, d. 1625.
Fermat (M.) Fr. math., d. 1665.
Fernelius. (Fernel) Fr. medical writer, d. 1558 ?
Firmicus. Astrologer, 4th century A.D.
Fontana. Of Naples, astron., d 1646 (or 1656 ?).
Fontenelle (S.) Author of "Pluralité des Mondes," d. 1757.
Fourier (M.) Fr. math. and nat. philos., d. 1830.
Fracastorius. Of Verona, physicn., poet, astrologer, d. 1553.
Explanations wanted: Fra Mauro (M.) Furnerius (R.)

Gärtner (S.) Q. Germ. architect, d. 1847. (?)
Gassendi. Fr. math., astron. and philos., d. 1655.
Gauricus. Ital. Gaurico, bishop and astrologer, d. 1558.
Geber. Arab. alchemist, 1080. (?)
Geminus. Of Rhodes, cir. B.C. 77.
Gemma Frisius. Dutch physic. and math. d. 1555.
Gérard (M.) Q. Of Cremona, translator of math. and other works from the Arabic, (?) d. 1187.
Gioja (M.) Of Amalfi, reputed inventor, (probably *improver*) of the compass, 1300.
Goclenius. Two of this name, of Marpurg. 1. Magnetist and math., d. 1621. 2. Philosoph. writer, d. 1628.
Godin (S.) Astron. d. 1760.
Grimaldi. Of Bologna, Ital. philos., associate of Riccioli, d. 1663,
Guerikè. Experimental philos., Magdeburg, d. 1686.
Guttemberg. Inventor of printing, of Mainz, d. 1467. (Gutenberg ?)
Explanation wanted of Gruemberger (S.)

Hæmus Mts. (M.) North of Thrace, Balkan.
Hagecius. Astron., Prague, 16th century.
Hanno (M.) Carthaginian navigator (Periplus), 570 B.C.
Harpalus. Gr. astron., lived before Meton (Censorinus).
Heinsius (S.) Astron., 18th century.
Hecatæus (M.) Of Miletus, Gr. hist. and geogr., d. 476 B.C.
Helicon. Mountain in Bæotia.

Hell (S.) Astron. Vienna, d. 1792.
Heraclides (Cape) Of Pontus, pupil of Plato.
Hercynian Mts. (M.) In Germany.
Herigonius. Astron. d. 1644.
Hermann. Swiss math. and nat. philos., d. 1733.
Hevel. Hevelius of Danzig, astron., d. 1687.
Hipparchus. Gr. astron., Alex. School, B.C. 160—125.
Horrebow (S.) Danish astron., d. 1764.
Hortensius. Dutch astron., d. 1639.
Humorum (Mare). Sea of humours (fluids of organic bodies).
Huyghens Mts. Dutch math. and astron., d. 1695.
Hyginus. (Poeticon astronomicon), uncertain date.
Hypatia. Of Alexandria (daughter of Theon), math. and philos, murdered A.D. 415.
Explanations wanted: Hahn (M.), Hainzel (R.), Hansteen (R.). Harbinger Mts. (B), Hausen (S.), Hase (S.) Hippalus (M.), Hommel (R.)

Imbrium (Mare). Sea of rains.
Inghir ·mi (M.) Ital. math. and astron., d. 1851.
Iridium Sinus. Bay of rainbows.
Isidorus. Bishop of Seville, encyclopædist (Origenes), d. 636.
Jansen (M.) Dutch, supposed inventor of telescope, 1610.

Kästner (S.) Math. and poet, d. 1800.
Kirch (S.) Germ. astron. d. 1710.
Kircher. Math., orientalist, &c., d. 1680.
Klaproth (M.) Prussian orientalist and geographer, d. 1835.
Kraft (S.) Germ. math. and philos., d. 1754.
Explanation wanted: Kies (S.).

(To be continued.)

EXTRACT FROM PLUTARCH'S DIALOGUE

"Concerning the Face which is seen in the Disk of the Moon."

(Tauchnitz ed. used.)

This treatise is sometimes referred to in works on astronomy. With much that is of no value, it contains some things that are curious and interesting, which it is endeavoured here to bring together, translating closely from the original. Sylla, the first speaker, observing that a sharp sight can discern the likeness of a face in the moon, quotes from the poet Agesianax:

"All of it shines round about with fire; then in the midst
Of paler blue than cyanos, appears the eye as of a girl,
And the soft forehead; and that is reddish to look at."

[What cyanos, or kuanos was is disputed, but the colour was a dark blue. This face might appear to be made out as follows: right eye, Mare Imbrium; the left, Mare Serenitatis; a well defined nose is formed by the high and bright space between them. extending to Sinus Æstuum and Sinus Medii; and the mouth is furnished by Mare Nubium and Mare Humorum. The Indian fancy of an antelope may be recognised, taking Mare Serenitatis and Mare Tranquillitatis as the head, and Mare

Fœcunditatis as one of the horns, with Mare Nectaris and Mare Frigoris for the other.] The opinion of Clearchus is then cited that this face is the image of the great sea reflected by the moon, for that the full moon is smoother and brighter than any mirror; and again Agesianax is quoted:

> "Or the great swell of the billowy sea opposite,
> Might seem like the representation of a flaming mirror."

[Humboldt says: "I was once very much astonished to hear a very accomplished Persian of Ispahan, who had certainly never read a Greek book, to whom I was showing in Paris the spots on the moon's face through a large telescope, propound the same hypothesis of reflection as that of Agesianax, as prevalent in his own country. 'It is ourselves that we see in the moon,' said the Persian, 'that is the map of our earth.' One of the interlocutors in Plutarch's Conversation on the Moon would not have expressed himself otherwise." The same notion, I think, has been found in India.] Further on (Sec. VI.), Cleanthes is said to have been of opinion that the Greeks ought to indict Aristarchus of Samos for impiety, as one who moved the hearth of the world (Kosmos); because the man endeavoured to satisfy appearances supposing the heavens were fixed, and that the earth moved in an oblique circle, at the same time also that it whirled round its own axis.

It is remarked that the earth is much larger than the moon, "for that the shadow of the earth extends the less as occasioned by a larger luminous body . . . . nevertheless the moon being caught by it in eclipses, gets free in barely three (spaces) of its own size. [This is correct.] Consider now, of how many moons the earth is (the equal), if it casts a shadow of which the narrowest breadth is that of three moons."

Alluding to Pharnaces, one of the interlocutors, who whilst assured of the stability of the earth, yet pitied the Æthiopians and the people of Taprobane [Ceylon], who lay beneath the moon's movement of translation, lest so great a weight should fall upon them. Leucius says, "Yet what supports the moon from falling is the motion itself, and the rootlike effect of the revolution; even as that which is placed in slings has, as a preventive to its falling down, the whirling round in a circle. For its natural motion leads everything, if it be not turned aside by anything else. Thus its weight does not lead the moon, that being counteracted as to its downward tendency by its revolution."

In Sect. X. Plutarch says that Aristarchus made the sun's distance from the earth more than eighteen times, and less than twenty times that of the moon, and that the greatest estimate of the moon's distance is fifty-six times the earth's semi-diameter. [Hipparchus supposed it = 60 times, which is very near the truth]

In Sect. XIX. Leucius observes concerning eclipses: "The earth because of its size altogether takes away the view of the sun, for the covering is great and has a duration like that of night; but the moon, even if it sometimes covers the whole sun, the eclipse has no duration nor breadth, but a certain radiance appears round the edge, which does not suffer the shadow to be deep and unmixed." And in Sect. XX., of the earth's shadow he says, "Being very broad at its base, like cones, and contracting by degrees, it terminates at the extremity in a sharp and fine end. Whence the moon when low down falling in to it is taken by it in very great circles, and passes through the deep and darkest part. But when high up—as if in a shoal—having been tinged by the thinness of the shade, it gets free quickly." [Although the earth's shadow extends

to a distance more than three times that of the moon, yet, rigorously speaking, the moon can never pass through the darkest part of it, or the *absolute* umbra (into which no light is refracted through the atmosphere of the earth) the apex of the cone of which is only 42 radii of the earth from the earth's centre, while the moon's distance is 60 radii. To enter the region of deep darkness (where of course it would be always invisible) the moon would need to be 54,000 miles nearer than ever it comes to the earth.]

In Sect. XXI., Pharnaces having remarked that the moon is not altogether invisible in eclipses, but shines with a certain awful colour, like that of burning coals, which is its own proper colour, Plutarch replies, that if that is really the case, nothing would be a clearer proof of the moon's being an earthly and dense body; "but," he continues, "it is not so, my dear Pharnaces, for there is much variation in the colours during an eclipse, and the mathematicians thus define them, distinguishing them according to the time and hour. If the eclipse take place in the evening, it appears exceedingly black until the third hour and a half; if at midnight, it sends forth the red and the more or less fiery; but from the seventh hour and a half the red disappears, and finally towards dawn it assumes a colour of dark blue and bluish grey, on which account the poets and Empedocles call the moon Glaucopis" [with eyes bluish grey].

In Sect. XXII, Apollonides says it is impossible that the shadows of clefts and chasms in the moon should be visible here, and such clefts and ruggednesses, too, as would be required to make so much shade, and which, moreover, are not discerned by us. To which Plutarch replies that it does not follow that to cast a great shadow an object must be of excessive magnitude, and he quotes the Iambic—

"Athos will cover the sides of the Lemnian cow."

"For the shadow of this mountain, it seems, stretches over the sea not less than 700 stadia [about 80½ miles, but the true distance is about 44 miles. Mt. Athos in Macedonia, now *Haghion Oros*, or *Monte Santo*, is 6,350 feet high] to a certain little bronze cow, and this by reason of the height of the object which sends the shadow." And he argues that to the great distance of the sun rather than to the size of the unevennesses on the moon the great shade is attributable, and that the surrounding rays of the sun prevent the prominences of mountains being clearly discerned in the day time, whilst the depths and hollows and shadowed spots are seen a long way off; even so it is not extraordinary if the illumined parts of the moon are not to be seen clearly, while the neighbouring shadowed parts by their contrast do not escape our vision." [There was a bronze figure of a cow in the forum of Myrina in the island of Lemnos, on which at the summer solstice, Pliny and others state that the shadow of Mt. Athos fell. Humboldt, after referring to this passage in Plutarch, says, "Under favourable circumstances of the moon's position and the state of the atmosphere, it is quite possible to distinguish with the naked eye the ridges of the Apennines, the dark wall-surrounded plain of Grimaldi, the detached Mare Crisium, and Tycho, with the mountain ridges and craters crowded around it. It has been said, not without probability, that it was in particular the aspect of the Apennine chain which occasioned the Greeks to regard the spots in the moon as mountains, &c.," and Webb ("Celestial Objects," p. 92) says, "The gradual entrance of the range into sunshine about 1st Quarter is a glorious spectacle, and its projection into the dark side which may be

seen without telescopic aid, probably gave rise to the early idea, mentioned by Plutarch, that the moon was mountainous."]

In reply to Theon, who had disputed the habitability of the moon, Plutarch (Sect. XXV.) argues that it does not follow if there are no persons in the moon that it is of no use, since only a small part of the earth itself is inhabited, the greater part being occupied by deserts and by the great sea, which nevertheless are far from being useless. He instances the fertility of the regions about Thebes and Syene, which are watered by dews and not rain, in favour of the moon's capability of supporting life, and he says, "it is the means to us of many soft and moist effects, such as the growth of plants, the putrefaction of flesh, the turning sour and thinning (?) of wines, the softening of woods, the easy child-births of women." . . . . "Those who suppose that living creatures there must be produced and supported in the same manner as here, appear to overlook the anomalies of nature, in which we find greater differences and dissimilarities betwixt animals themselves, than between them and inanimate objects, ... as if then, we were unable to approach or to touch the sea, and only beheld it afar off, and understood that its water is bitter and undrinkable. and some one should say that it nourishes in its depths many large living creatures of all kinds, and is full of beasts who make use of the water as we do of the air, he would seem to treat of fables and marvels. Even so is it with us apparently, in regard to the moon, when we disbelieve that any people dwell there. But I should imagine they would rather much more wonder at the earth, seeing it like sediment and mud, always appearing in wet, and mists, and clouds, a place dark, lowly, and motionless, if (notwithstanding) it produces and nourishes living creatures which partake of motion, breathing, and heat. And if ever they heard the lines of Homer [Il. xx. 64 of Pluto's domains]—

'Dismal, loathsome, and dark, by the gods all held in abhorrence,'

and [Il. viii. 16 of Tartarus]—

'So far beneath hades, as is the heaven from the earth,'

they would certainly affirm that they were spoken of this place, and that Hades and Tartarus are both situated here, and that the only earth is the moon, distant alike from the regions above and from these lower ones."

The rest of the conversation (Sect. XXVI.—XXX.) is of a mythical character. Sylla describes a group of islands, Ogygia being one of them, five days sail from Britain to the north-west, in one of which Kronos is confined by Zeus, and is served by Greeks who sail thither for the purpose, and where "the sun is hidden one hour less than thirty days, and it is a night in which the darkness is not deep, but irradiated by a gray twilight from the west," and he narrates what he heard from a person who received it from the servants of Kronos, concerning the destinies of the soul in relation to the moon, in the which "whilst the souls of the good quickly pass through the dark place, those of the persons punished are borne down into it lamenting and shrieking (on which account most people are accustomed in eclipses to make a clatter with brazen vessels, and rattling sounds at the souls), and the so-called face frightens them when they get near to it, looking like something awful and terrible; yet it is nothing of the kind, but as with us the earth has deep and large recesses, one on this side emptying itself within towards us through the pillars of Hercules [*i.e.*, the Mediterranean], and outside, the Caspian, and those about the Red Sea, so are these depths and hollows of the

moon. They call the largest of them the Bay of Hecate, where also the souls receive retribution according to that which in their previous state of demons, they may have either suffered or done. And there are two small ones, for the souls pass through them; at one time to the heaven of the moon, at another towards the earth (of it). The regions toward the heaven of the moon are called the Elysian Plain, those on this side belong to Persephone—not (the Persephone) of the under world."

[In order that the longest night should be of one month, it would be necessary to go beyond the 67th degree of latitude, which is farther north than Iceland. But the above account of the long night may have been only obtained by report, if neither Phœnicians nor Greeks ever reached so high a latitude. In the later writers departed souls were called demons.]

GEORGE J. WALKER.

REVIEWS.

Report of the Radcliffe Observer to the Board of Trustees, read at their meeting, held July 11th, 1876. [Printed by order of the Trustees for Private Circulation.]

Another good year's work in the Radcliffe Observatory! Although Mr. Main remarks "that the sameness of the work precludes novelty or especial interest in the yearly statement, and that it can only be thorougly appreciated in observatories pursuing the same tedious and uniform investigations," we believe there is not a true lover of astronomy who would peruse this report without great satisfaction. It includes the time between June 30th, 1875, and June 30th, 1876. Since the resignation of Mr. G. Keating, on March 31st of the present year, the *personnel* of the observatory is as follows:—First Assistant, Mr. John Lucas; Second Assistant, Mr. Fred. Bellamy; Third Assistant, Mr. Henry Bellamy; Computer to the Establishment, Mr. Luff. The Carrington Transit-circle, Heliometer, and other instruments are in good condition. The 10 ft. Reflecting Telescope, made by Sir William Herschel, has been lent to the Exhibition of Scientific Instruments, &c. In spite of very unfavourable weather there have been observed 2,303 transits, 3,471 zenith-distances, 1 187 stars, the sun on the meridian 100 times, and the moon 51 times. Observations have been made of all the primary planets; the outer ring of Saturn has been observed 7 times, and 64 observations of double stars have been made with the heliometer; with which also 11 occultations have been observed, and 35 observations of the phenomena of Jupiter's satellites have been made. The sun has been examined 131 days, and the spots on 85 of these days delineated in position and circumstances. Photographic meteorology has been carried on successfully by Mr. Lucas, by whom also a considerable number of shooting stars have been observed. The volume of Observations for 1873 was circulated in February last, and the volume for 1874 is partly in print. The Reductions of 1875 are nearly complete.

We find also that a *Third Radcliffe Catalogue* is in preparation, and that Mr. Luff is now occupied with it. This catalogue will probably contain about 4,000 stars, the result of nine years' observations, from 1862 to 1870 both inclusive. It will include, amongst others, almost all those stars in the British Association Catalogue whose positions have been imperfectly or badly determined. We shall rejoice to learn

that additional assistance is granted to expedite this important work, as it appears that the other duties of the observatory, and heavy pressure of current reductions have hitherto retarded it. A Radcliffe Catalogue, we need hardly say, is prized wherever astronomy is cultivated, and the grant of a little extra computing power in a work of this magnitude would be very grateful to expectant astronomers.

Useful additions of serial and other works, by presentation or purchase, have been made to the library. On the subject of the necessity of frequent visits from London, Mr. Main observes, "An astronomical observatory does not stand in so isolated a position as it did formerly, but is allied very closely to many of the other physical sciences, and the routine of the observing and computing rooms must, in the case of the director, be frequently interfered with, by his necessary connection and interest in the discussions which are going on in the outer world, and in which he is expected to take part." In conclusion, the Radcliffe observer gratefully testifies to the "cheerful zeal and industry of every person connected with the establishment." We forget at this moment what celebrated Frenchman, in instructing a young diplomatist, ended by enjoining "and above all, no zeal!" and what was meant in this case is not hard to conceive. In science, however, we welcome any amount of it; and it is pleasant when veteran astronomers, whether at Oxford or elsewhere, can testify with pleasure to the zeal of their assistants, who, trained under their auspices, are now rendering valuable service to astronomy, and who may in some cases hereafter win for themselves renown in its history.

Results of astronomical observations made at the Royal Observatory, Cape of Good Hope, during the years 1871, 1872 and 1873, under the direction of Edward James Stone, M.A., F.R.S., F.R.A.S., &c., &c.

This volume contains an introduction, tables of instrumental corrections, star ledgers and star catalogues—282 stars having been observed in 1871, 417 in 1872, and 707 in 1873. We also have some observations of the sun, occultations of stars by the moon, and of Winnecke's comet in 1871, observations of Tuttle's comet in 1871 and 1872, and of Tempel's comet in 1872.

In the introduction Mr. Stone tells us that his present object is the formation of a general catalogue of southern stars to the 7th magnitude, using Lacaille's as a working catalogue. The work has been much impeded by the time that had to be spent on the 1860 catalogue, and also by the deaths of his assistants, but Mr. Stone hopes to finish it in 1878.

In this volume, which is the first instalment of the materials for the projected catalogue, are to be found observations of all Lacaille's stars within 15° of the south pole, and of nearly all stars to the 7th magnitude within the same zone. The instrument used has been the Cape transit circle, which is similar in power and construction to the Greenwich instrument; it was erected in 1855.

During the interval, 1856—1872, it was found that the relative subsidence of the western over the eastern pivot amounted to 4″ per annum, in 1872 the error was over-corrected, so that the level error is now large, the correction in one instance amounting to + 1·875s.

The observations in right ascention were generally made by "eye and ear" as the stars observed were near the pole, but some transits were observed by the galvanic method; care being taken to determine the

clock error by the "eye and ear" method if the stars for place were observed by it.

The only difficulty Mr. Stone has met with in reducing the transit observations is one arising from a change of "personal equation" of one of his assistants, which change took place after an illness, from which time the assistant observed stars systematically late, and for slow moving stars the error is considerable, as much as $+0^s{\cdot}160$ having to be applied as a correction to the azimuth error determined by this observer. Unfortunately the change was not discovered for more than a year, so that it gave some trouble in the reductions. Strange to say, as soon as this peculiarity was pointed out to the assistant it disappeared after a few days.

It appears that the circle observations are not quite so satisfactory. In the first place, the Nadir determinations of the zenith point corrections show annual changes of $\pm 10''$ from the mean, though the determinations on the same day are generally accordant, and Mr. Stone considers it prudent to reduce each night's observations with the zenith point correction determined on the same night and by the same observer. A change in flexure has also been detected; in 1855 its amount was found to be $-0''{\cdot}26$. A new determination was made in 1870, Nov., and the result came out $-0''{\cdot}75$, the observations were repeated on, 1871, March 6 and 7, and in 1871, October, and the mean of these determinations gave $-0''{\cdot}617$. N. P. D. ledgers have been reduced with the flexure $-0''{\cdot}26$, so that they require a small correction on this account. But what troubles Mr. Stone most of all is the systematic difference of about $0''{\cdot}86$ between the zenith point corrections determined by reflection observations of stars and by the Nadir reflecting eye-piece. After much consideration Mr. Stone has determined to reduce all his circle observations with corrections determined by the reflecting eye-piece, because observations of stars by reflection are rendered uncertain by the windy weather which prevails during the summer months, and also because, if the cause of the discordance should be discovered, corrections can be applied more easily if the reductions are made in this way.

By comparing a number of observations of stars above and below the pole Mr. Stone is led to believe that there is a systematic discordance in the circle readings, then assuming that the readings are affected by an error of the form A. sin. Z. + B. cos. Z. + C. sin. 3 Z., he computes a table of corrections which he has applied to his ledger results in N. P. D.

In the reductions the assumed latitude was $33° 56' 3''{\cdot}2$, which is that determined by Henderson.

Mr. Stone tells us that he would much prefer to print his observations in detail, as is done at Greenwich, instead of comprising three years' work into one volume, but that, of course, it would require a larger staff, would entail greater expense, and would delay the publication of his observations considerably.

Let us hope that Mr. Stone will be enabled speedily to publish for our edification his General Catalogue of Southern Stars to the 7th Magnitude.

The only errata that have caught our eye are—Introduction, page xxiv., line 6 from bottom, for *latitudes* read *latitude*; line 5 from bottom for *discordance* read *discordances*.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

ZODIACAL LIGHT.

Sir,—Two or three times during the spring of this year and last, whilst observing the zodiacal light, I noticed an apparent continuance of it through Leo and Virgo in the S.E.; thinking, however, it must be only due to faint stars or mist I made no note of it.

Last night, whilst watching for meteors, and looking in the direction of Pegasus, I lowered my eyes, and immediately noticed a distinct difference in the darkness of the sky, there being a similar band of light through Pisces and Aries to that seen in the spring. I could trace it distinctly to the Pleiades, but it then became lost in the Milky Way. I should be glad to know if any one can corroborate these observations.

I saw 14 meteors between the hours of 9 and 11. Most of them appeared to come from a large area of radiation comprising Aries, Triangulum and part of Perseus. They were all small. On Sept. 21st I counted 43 meteors in a watch extending from 8.15 to 11. They were almost all extremely small. Ten of the smallest emanated from a point 1° north of the centre of a line joining α and γ Pegasi. Some were from Lacerta, Perseus, Aquarius, and other radiants.

At 5 p.m. on the 24th Sept., there were portions of a very brilliant rainbow visible at Chelmsford. The primary bow was quadruple and the secondary bow double.

Writtle, near Chelmsford: H. CORDER.
October 14, 1876.

STAR MAGNITUDES.

Sir,—Heis' estimates of star magnitudes, as given in the catalogue to his Atlas, are, as a rule, so very accurate that any discrepancies in the relative brilliancy of stars observed by him are worthy of notice as indications of variable light. The following may be noticed:—

1. β Bootis, rated by Heis at 3 mag., and γ Bootis 3·4 mag. In March, 1875, and March, April, June, and July, 1876, I observed γ to be distinctly brighter than β. In June, 1876, the difference seemed nearly half a mag. in favour of γ.

2. β Scorpii, rated 2 mag. by Heis, and δ Scorpii 2·3 mag. On the 10th of this month I observed these stars to be almost exactly equal, δ perhaps *very* slightly the *brighter* of the two. Heis must have made some mistake in rating β Scorpii as 2 mag., unless it be variable. Both β and γ seem to me nearer 3 mag. than 2 mag.

3. σ Sagittarii is rated 2·3 mag. by Heis, and λ Scorpii 3 mag., but the latter is now certainly the brighter of the two, and fully 2 mag. The low meridian altitude of λ Scorpii at Münster may however account for its being rated 3 mag. by Heis.

4. Heis rated γ Corvi as 2 mag., but it seems to be about $2\frac{1}{2}$ mag., and

about equal to κ Orionis. It is certainly less than the brighter stars in the Plough, rated 2 mag. by Heis. Several of the stars in Corvus have, however, been suspected of variability.

Umballa, Punjab : Yours faithfully,
August 14, 1876. J. E. GORE.

THE COMPANIONS OF THE POLE STAR.

Sir,—On 25th September, between 6 and 7 p.m., I saw the two small companions of the pole star quite plainly with my 6¼ With-Browning reflector, and my wife distinctly recognised them in the position stated by M. Böe. Since then I have on one or two occasions just recognized them from knowing what to look for, but not plainly enough to have been sure of their existence.

I do not think they are difficult *optical* tests, as they are very brilliant for their minute size, but they will probably prove extremely troublesome *weather* tests, and only fairly visible on exceptionally good occasions. Perhaps strong twilight, or even moonlight, may favour their exhibition. When I saw them well the sky was very light.

Nights that do for many difficult doubles fail with these objects, as a very little flashing, or unsteadiness, or exaggeration of rings prevent their being seen. I fear it will be very difficult to watch them with any constancy. Large telescopes may have failed from their making the pole star very bright, and then occasioning radiation, but perhaps more probably from their requiring exceptionally good weather for their best performance.

Ashdown Cottage, Forest Row : I am, &c.,
October 17, 1876. HENRY J. SLACK.

σ OCTANTIS.

In the preface to the *Nautical Almanac* for 1879, Mr. Hind states that the place of σ Octantis for that year is taken from Stone's "Places of eight close southern polar stars." It appears that the *Nautical Almanac* place of this star for the year preceding 1879 is considerably in error. For instance, in 1878, the *N. A.* mean position is R. A. 18h. 21m. 3·42s. and N. P. D. 179° 16′ 31″·24, whilst Stone's place for the same year is R. A. 18h. 20m. 53·74s., and N. P. D. 179° 16′ 33″·92. The *Nautical Almanac* place, previously to 1879, has been worked up from Maclear's observations of 1834, and the error is to be ascribed not to any fault in these observations, but to an insufficiency in the correction for precession applied from year to year, which of course gives an incorrect amount of annual variation, and produces, after the lapse of years, a large error in the star's tabular place.

A. W. DOWNING.

THE SATELLITES OF SATURN DURING AUGUST 1876.

In common with every observer of the Saturnian system, I am under a considerable obligation to Mr. Marth for his valuable Ephemeris of the satellites, which has rendered a very easy matter what were otherwise a difficult one, viz., the identification of each object, whatever the hour of observation. If the following notes are of any interest to him, or to other readers of the *Astronomical Register*, they are at their service.

Micrometer measurement of the places of *Mimas* and *Enceladus* being impossible, except in a much larger telescope than my own, and those of *Tethys*, *Dione*, and *Rhea* often difficult and unsatisfactory owing to unsteadiness of the atmosphere; most of the observations were made by obtaining the difference of R. A. of the centre of the globe and the satellite, by transits across the field. I found it better to rely upon their disappearance behind a stop which covered half the field of a Browning achromatic power of 450, than by the usual mode of transiting a wire, because in a series of transits by the two methods, those by the former were most accordant.

Whenever possible, a series of transits of each object, varying from five to eighteen was taken, and the mean entered in the table.

The places of *Titan* and *Japetus* were determined exclusively by this method, and those of *Rhea*, *Dione* and *Tethys* as often as practicable; when otherwise their positions were estimated, and carefully laid down on a plan of the system to scale, whence their distances could be accurately measured off and tabulated. Not until the last day or two did I know of the very close agreement in general with Marth's positions of *Titan* and *Japetus*, as until then I had not applied the corrections for the hour of observation.

The whole of the observations of *Titan* and *Japetus* are given. Of the others only those of which the time of observation was nearest to Marth's calculated positions, several of *Rhea*, *Dione* and *Tethys* being omitted.

Aperture used = 8·15-in. speculum by With, and a reflecting prism.

Brighton.

HENRY PRATT.

Differences between the calculated and observed difference of R. A. of the centre of Saturn and

1876. August.		Titan. Calculated Place.	Titan. Observed Place.	Titan. Difference.	Japetus. Calculated Place.	Japetus. Observed Place.	Japetus. Difference.
	h.	s.	s.	s.	s.	s.	s.
3	19	− 8·99	9·8	+ ·91	+ 3·78	3·5	+ ·28
5	19·9	−12·38	12·25	− ·13			
8	19·6	− 3·86	3·5	+ ·36	−10·86	11·	+ ·14
10	19·5	+ 6·53	7·0	+ ·47	−16·38	16·4	+ ·02
11	20·	+10·42	11·1	+ ·68	−19·07	19·1	+ ·03
12	20·	+12·69	13·	+ ·31	−21·59	21·6	+ ·01
13	20·5	+13·14	13·5	+ ·36	−24·03	23·8	− ·23
14	19·	+11·81	12·6	− ·79	−26·10	26	− ·10
15	20·3	+ 8·62	9·	− ·38	−28·36	28·4	+ ·04
16	19·7	+ 4·83	5·1	− ·27	−30·25	29·9	− ·35
20	20·	−11·93	11·9	− ·03	−36·09	35·9	− ·19
21	20·4	−12·47	12·3	− ·17	−37·03	36·7	− ·33
23	21·5	− 7·34	7·6	− ·26	−38·19	37·5	− ·69
25	20·	+ 2·16	3·2	+1·04			
27	20·7	+10·77	11·3	+ ·53			
29	20·7	+13·17	13·7	+ ·53	−35·86	35·7	+ ·16
30	20·8	+11·61	11·9	+ ·29	−34·66	34·4	+ ·26

If the differences above in the case of *Titan* are reliable, they show that from 8th to 13th in traversing the N.E. portion of its orbit it was in

advance of its calculated position; a supposition which seems strengthened by its return to the same part of its path between 24th and 29th August, when it again shows an advance.

August, 1876.	Position from Mr. Marth's tables.	Calculated time of position.	Time of observation.	Interval in arc.	Corresponding dist. from centre of globe by tables.	Estimated dist. from centre of globe.	Remarks.
		h.	h.	°	"	"	
					Rhea.		
5	E. elong.	21·6	19·9	− 5·6	81 E.	82·5	By transit = 5·5s. Almost on major axis. Apparently +.
11	sp.	17·9	20·7	+ 9·2	33 W.	35·	At 20h. on a line with S. limb of globe.
14	E.	22·9	20·	− 9·5	80 E.	88·	By transit 6·1 s. N. of maj. ax.
15	sf.	21·5	20·3	− 3·9	25 E.	25·	
20	sp.	19·2	20·	+ 2·4	24 W.	24·	
21	W.	17·8	21·7	+12·8	79 W.	84·	By transit 5·4s. = 81".
23	E.	24·1	21·7	− 7·9	80 E.	87·	Just S. of major axis. Apparently +. By transit 5·9s· = 88"·5.
25	inf. S.	3·3	21·5	+60·	70 W.	68·	
30	W.	19·1	21·	+ 2·9	80 W.	84·	By transit 5·5s. = 82"·5.
					Dione.		
3	W. elong	17·5	19·	+ 8·2	56 W.	52·	
11	W.	23·	20·6	−13·2	56 W.	55·	N. of maj. ax. Brighter than Rhea.
14	W.	16·8	19·5	+14·8	55 W.	55·	N. of maj. ax.
21	nf.	0·8	21·7	+114·9	53 E.	52·5	By transit 3·5s. = 52"·5. S. of maj. ax., about ½ rad. of globe.
23	nf.	18·7	21·5	+15·4	35 E.	34·	
29	E.	18·9	21·	+11·5	56 E.	56·	
30	W.	27·8	21·	−37·4	45 W.	46·	
					Tethys.		
5	E.	19·9	19·3	− 4·7	45 E.	38·	N. of maj. ax. At 20·5h. slightly S. of maj. ax.
8	W.	16·1	21·2	+40·2	35 W.	36·	
20	E.	23·3	20·	−26·	41 E.	39·	N. of maj. ax., distance scarcely equal to length of maj. ax.
21	W.	22·	21·7	− 2·3	45 W.	48·	By transit 3·2s. =48". Just S. of maj. ax.
23	W.	19·4	21·5	+16·5	43 W.	43·	N. of maj. ax.
					Enceladus.		
3	E.	21·7	19·	−29·4	30 E.	30·	
10	E.	18·6	19·7	+11·9	34 E.	37·	
14	E.	21·5	20·8	− 7·6	35 E.	30·	
21	E.	18·3	21·7	+37·	28 E.	31·	On line with S. margin of ring.
23	W.	19·8	22·	+23·9	32 W.	35·	Just S. of maj. axis.
					Mimas.		
8	W.	20·9	21·2	+ 4·7	29 W.	28·	
10	W.	18·3	20·	+26·8	25 W.	24·	
25	W.	21·1	21·5	+ 6·3	29 W.	28·	On major axis.

THE CONJUNCTION OF TITAN WITH SATURN'S RING.

On 18th Sept., 1876, I observed a conjunction of *Titan* with the preceding edge of the ring, but the time of the occurrence was not included in Mr. Marth's tables, perhaps because of the distance of *Titan* from the major axis. However, having been prevented from observing the satellite in inf. conj. with the centre of the planet, which was indicated in the tables, preparation was made for its conj. with the ring. Using a power of 450, and having carefully placed the straight edge of the diaphragm (referred to in my paper on the "Satellites for August") on the major axis of the ring, I rotated it by the position circle through 90°, and set it in contact with the ring's preceding edge.

At 21h. 15m. Sid. Time, *Titan* was so close to the diaphragm that it required attention to decide that it still had not reached it. At 21h. 20m. it was almost yet still scarcely in contact. At 21h. 22m. *Titan* was apparently truly in conj. with the preceding edge.

Brighton. HENRY PRATT.

LUNAR OBJECTS SUITABLE FOR OBSERVATION IN NOVEMBER, 1876.

By W. R. Birt, F.R.A.S., F.M.S.

Among the drawings of Fracastorius lately received are two by Simms dated as follows:—One from sketches made on April 29, May 29, and June 26, 1876, the other August 8, 1876. These drawings, as well as one by Durrad dated April 28, 1876, contain a line of objects stretching from the north-east end of the east wall to a point not far from the northern termination of the west wall. This line is admirably situated for a base line in delineating the outline of Fracastorius by *measurements*, the objects comprising it are (1) the shallow crater X of the synopsis, see List for August, No. 164, p. 191. (2) The low mountain with three peaks, XII., see List for October, No. 166, p. 245. (3) An object seen by Ingall, Elger, and Birmingham in 1870. Between 1871, January, and 1873, April, there is no record of it, but in the interval, April, 1873, and April, 1876, it was seen by Gaudibert, by Durrad April 25, 1876, and by Simms in April, May or June, and on August 8th, 1876, Durrad draws and describes it as a mountain; it is XIV. of the synopsis. (4) XIII. of the synopsis, which is drawn and described by Durrad as a mountainous ridge adjoining a lower ridge connected with the central mountain IX. of synopsis, see List for June, No. 162, p. 148. The lower connecting ridge of Durrad is somewhat in the direction of Miss Ashley's ridge, but not in its locality. (5) XXIII. of the synopsis, a mountain seen by Durrad on April 25, 1876, and by Simms in April, May or June, 1876. Durrad gives a sixth object in this line, viz., a semi-circular ridge on the north-east of XII.; it is XXII. of the synopsis. Will observers please say with what apertures they can detect any of these objects?

DISCOVERY OF TWO PLANETS.

(From *Astronomische Nachrichten.*)

1. Planet discovered by Prosper Henry: 1876, Sept. 28. 12h. 30m. M. T. Paris.
   α 0h. 26m. 24s. $\delta + 5° 22'$. Mag. 10·8.
2. Planet discovered by Watson: 1876, Sept. 28th, α 0h. 22m. $\delta + 5° 9'$. Movement southwards. Mag. 11.

ASTRONOMICAL OCCURRENCES FOR NOVEMBER, 1876.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Saturn.
Wed	1	11 30 12 9 13 21	○ Full Moon Occultation of B.A.C. 782 (6½) Reappearance of ditto			7 30·6
Thur	2	10 20 10 38 18 20 19 14 18 23 19 13 18 51 19 35 19 0 19 15 19 21	Occultation of 66 Arietis (6½) Reappearance of ditto Occultation of 17 Tauri (4) Reappearance of ditto Occultation of 16 Tauri (5½) Reappearance of ditto Occultation of 20 Tauri (5) Reappearance of ditto Near approach of 19 Tauri (5) Occultation of 23 Tauri (5) Reappearance of ditto	Satellites of Jupiter invisible through his nearness to the Sun.		7 26·7
Fri	3	6 48 7 31	Occultation of χ^1 Tauri (5½) Reappearance of ditto			7 22·7
Sat	4	10 4 10 51 18 39	Occultation of B.A.C. 1746 (6½) Reappearance of ditto Near approach of 136 Tauri			7 18·8
Sun	5					7 14·8
Mon	6		Sidereal Time at Mean Noon, 15h. 4m. 10·46s.			7 10·9
Tues	7	9 38	Near approach of γ Cancri (4½) Sun's Meridian Passage 16m. 10·25s. before Mean Noon			7 7·0
Wed	8	5 16	☾ Moon's Last Quarter			7 3·1
Thur	9					6 59·2
Fri	10	13 54	Occultation reappearance of τ Leonis (5)			6 55·3
Sat	11		Saturn's Ring: Major axis=39″·57 Minor axis=6″·38			6 51·4
Sun	12	6 23	Conjunction of Moon and Venus 4° 8′ N. Conjunction of Moon and Mars 4° 0′ N.			6 47·5
Mon	13					6 43·6
Tues	14	18	Conjunction of Moon and Mercury 5° 36′ N.			6 39·8

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Wed	15	12 47	● New Moon Illuminated portion of disc of Venus=0·730 Illuminated portion of disc of Mars=0·973			6 35·9
Thur	16	4 19	Uranus at quadrature with the Sun Conjunction of Moon and Jupiter 5° 34′ N.			6 32·0
Fri	17		Sidereal Time at Mean Noon 15h. 47m. 32·58s.			6 28·2
Sat	18		Sun's Meridian Passage 14m. 33·57s. before Mean Noon			6 24·4
Sun	19			Satellites of Jupiter invisible through his nearness to the Sun		6 20·5
Mon	20					6 16·7
Tues	21					6 12·9
Wed	22					6 9·1
Thur	23	16 26 6 47 2 16	☽ Moon's First Quarter Near approach of ι Aquarii (4) Saturn at quadrature with the Sun Conjunction of Moon and Saturn 0° 31′ S.			6 5·2
Fri	24					6 1·4
Sat	25					5 57·6
Sun	26					5 53·8
Mon	27	19	Conjunction of Mars and Venus 1° 15′ N.			5 50·0
Tues	28					5 46·3
Wed	29	7 57 8 54 9 33	Occultation of 47 Arietis (6) Reappearance of ditto Near approach of ε Arietis (4½)			5 42·5
Thur	30	23 3 3 5 3 47 3 35 4 10 3 59 4 49 4 3 4 51 18 48 19 10	○ Full Moon Occultation of 23 Tauri (5) Reappearance of ditto Occultation of η Tauri (3) Reappearance of ditto Occultation of 27 Tauri (4) Reappearance of ditto Occultation of 28 Tauri (5½) Reappearance of ditto Occultation of χ^1 Tauri (5½) Reappearance of ditto			5 38·7
DEC. Fri	1	15 59	Near approach of B.A.C. 1648 (6½)			5 35·0

THE PLANETS FOR NOVEMBER.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	13 27 30	S. 6 52	6″·1	22 39·3
	9th	14 11 59	S. 11 34	5″·3	22 52·2
	17th	15 0 45	S. 16 18	4″·9	23 9·4
	25th	15 51 42	S. 20 18½	4″·6	23 28·8
Venus ...	1st	11 54 40	N. 2 4	16″·7	21 6·7
	9th	12 29 34	N. 1 21	15″·7	21 10·1
	17th	13 4 59	N. 4 51½	15″·1	21 13·9
	25th	13 41 5	N. 8 20	14″·3	21 18·5
Saturn ...	1st	22 16 18	S. 12 41	16″·2	7 30·6
	9th	22 16 20	S. 12 39½	16″·0	6 59·2
	17th	22 16 48	S. 12 36	15″·8	6 28·2
	25th	22 17 42	S. 12 30	15″·7	5 57·6
Neptune ...	4th	2 8 9	N. 11 1	...	11 10·0
	16th	2 6 55	N. 10 55	...	10 21·6

Mercury rises nearly two hours before the sun at the beginning of the month, the interval decreasing.

Venus rises about three hours after midnight, the interval slightly increasing.

Saturn may be observed till midnight at the beginning of the month, setting earlier each night.

SATELLITES OF SATURN.

Approximate Greenwich sidereal times of conjunctions and greatest elongations occurring between 18h. and 6h. Greenwich sidereal time.

f. conj. with following edge of ring.
p. „ „ preceding „ „
sup. superior conj. with centre of ball.
inf. inferior „ „
n. north of ring.
s. south „
e. at greatest eastern elongation.
w. „ western „

1876.	Gr. Sid. Time.		
	h.		
Nov. 1	20·0	Tethys.	w.
	21·3	Encel.	w.
	21·9	Mimas.	w.
	2·3	Encel.	np.
	3·9	Tethys.	np.
	4·4	Rhea.	w.
2	18·7	Tethys.	e.
	18·8	Encel.	sf.
	18·9	Dione.	np.
	20·6	Mimas.	w.
	1·2	Encel.	sp.
	2·6	Tethys.	sf.
	2·7	Dione.	nf.
	3·0	Rhea.	np.
3	19·3	Mimas.	w.
	22·7	Encel.	e.
	1·3	Tethys.	np.

1876.	Gr. Sid. Time.		
	h.		
	3·8	Encel.	sf.
	3·9	Dione.	sf.
4	18·0	Mimas.	w.
	20·3	Encel.	np.
	0·1	Tethys.	sf.
	0·2	Dione.	w.
	2·7	Encel.	nf.
	5·3	Mimas.	e.
	12·9	Titan.	inf. 29″ s.
5	18·4	Rhea.	sp.
	19·2	Encel.	sp.
	20·5	Dione.	nf.
	22·8	Tethys.	np.
	0·2	Encel.	w.
	4·0	Mimas.	e.
	5·3	Encel.	np.
	5·7	Tethys.	nf.

1876.	Gr. Sid. Time. h.		
6	21·5	Tethys.	sf.
	21·7	Dione.	sf.
	21·8	Encel.	sf.
	1·6	Dione.	inf. 9″ s.
	2·7	Mimas.	e.
	4·1	Encel.	sp.
	4·4	Tethys.	sp.
	5·5	Dione.	sp.
7	18·1	Dione.	w.
	20·2	Tethys.	np.
	20·3	Rhea.	sup. 12″ n.
	20·6	Encel.	nf.
	0·8	Rhea.	nf.
	1·4	Mimas.	e.
	1·7	Encel.	e.
	3·1	Tethys.	nf.
8	18·2	Encel.	w.
	18·9	Tethys.	sf.
	23·2	Encel.	np.
	23·4	Rhea.	e.
	0·0	Mimas.	e.
	1·9	Tethys.	sp.
	3·0	Dione.	e.
	5·6	Encel.	nf.
9	19·5	Dione.	inf. 9″ s.
	22·1	Encel.	sp.
	22·1	Rhea.	sf.
	22·7	Mimas.	e.
	23·3	Dione.	sp.
	0·6	Tethys.	nf.
	2·6	Rhea.	inf. 12″ s.
	3·1	Encel.	w.
10	19·6	Encel.	e.
	21·4	Mimas	e.
	23·3	Tethys.	sp.
	0·5	Dione.	np.
	0·7	Encel.	sf.
	5·8	Rhea.	w.
11	20·1	Mimas.	e.
	20·9	Dione.	e.
	22·0	Tethys.	nf.
	23·6	Encel.	nf.
	4·5	Rhea.	np.
	4·6	Encel.	e.
	5·9	Tethys.	e.
12	18·8	Mimas.	e.
	20·7	Tethys.	sp.
	21.1	Encel.	w.
	2·2	Encel.	np.
	4·6	Tethys.	w.
	5·8	Dione.	w.
	6·1	Mimas.	w.
	6·4	Titan.	sup. 28″ n.
13	18·4	Dione.	np.
	18·6	Encel.	sf.
1876.	Gr. Sid. Time. h.		
	19·5	Tethys.	nf.
	1·0	Encel.	sp.
	2·2	Dione.	nf.
	3·3	Tethys.	e.
	4·8	Mimas.	w.
14	18·2	Tethys.	sp.
	19·9	Rhea.	sp.
	22·6	Encel.	e.
	2·1	Tethys.	w.
	3·4	Dione.	sf.
	3·5	Mimas.	w.
	3·6	Encel.	sf.
15	18·6	Rhea.	w.
	20·1	Encel.	np.
	23·7	Dione.	w.
	0·8	Tethys.	e.
	2·2	Mimas.	w.
	2·5	Encel.	nf.
16	19·0	Encel.	sp.
	20·0	Dione.	nf.
	21·7	Rhea.	sup. 12″ n.
	23·5	Tethys.	w.
	0·0	Encel.	w.
	0·9	Mimas.	w.
	2·3	Rhea.	nf.
	5·1	Encel.	np.
17	21·2	Dione.	sf.
	21·6	Encel.	sf.
	22·2	Tethys.	e.
	23·5	Mimas.	w.
	0·9	Rhea.	e.
	1·1	Dione.	inf. 9″ s.
	4·0	Encel.	sp.
	5·0	Dione.	sp.
18	20·5	Encel.	nf.
	20.9	Tethys.	w.
	22·2	Mimas.	w.
	23·6	Rhea.	sf.
	1·5	Encel.	e.
	4·1	Rhea.	inf. 12″ s.
	4·8	Tethys.	np.
19	18·0	Encel.	e.
	19·7	Tethys.	e.
	20·9	Mimas.	w.
	23·1	Encel.	np.
	2.5	Dione.	e.
	3·6	Tethys.	sf.
	5·5	Encel.	nf.
20	18·4	Tethys.	w.
	19·0	Dione	inf. 9″ s.
	19·6	Mimas.	w.
	21·9	Encel.	sp.
	22·9	Dione	sp.
	2·3	Tethys	np.
	3·0	Encel.	w.

1876.	Gr. Sid. Time. h		
	6·0	Rhea.	np.
	12·9	Titan.	inf. 28″ s.
21	18·3	Mimas.	w.
	19·5	Encel.	e.
	0·1	Dione.	np.
	0·5	Encel.	sf.
	1·0	Tethys.	sf.
	5·6	Mimas.	e.
22	20·4	Dione.	e.
	23·4	Encel.	nf.
	23·7	Tethys.	np.
	4·3	Mimas.	e.
	4·5	Encel.	e.
23	21·0	Encel.	w.
	21·4	Rhea.	sp.
	22·4	Tethys.	sf.
	2·0	Encel.	np.
	3·0	Mimas.	e.
	5·3	Dione.	w.
	5·4	Tethys.	sp.
		Moon near.	
24	18·0	Dione.	np.
	18·5	Encel.	sf.
	20·1	Rhea.	w.
	21·2	Tethys.	np.
	0·9	Encel.	sp.
	1·7	Mimas.	e.
	1·7	Dione.	nf.
	4·1	Tethys.	nf.
	5·9	Encel.	w.
25	18·8	Rhea.	np.
	19·9	Tethys.	sf.
	22·4	Encel.	e.
	23·3	Rhea.	sup. 12″ n.
	0·3	Mimas.	e.
	2·8	Tethys.	sp.
	2·9	Dione.	sf.
	3·5	Encel.	sf.
	3·8	Rhea.	nf.
26	18·6	Tethys.	np.
	20·0	Encel.	np.
	23·0	Mimas.	e.
	23·2	Dione.	w.
	1·5	Tethys.	nf.
	2·4	Encel.	nf.
	2·5	Rhea.	e.
27	18·9	Encel.	sp.
	19·6	Dione.	nf.
	21·7	Mimas.	e.
	23·9	Encel.	w.
	0·3	Tethys.	sp.
	1·1	Rhea.	sf.
	5·0	Encel.	np.
	5·7	Rhea.	inf. 12″ s.
28	20·4	Mimas.	e.
	20·8	Dione.	sf.
	21·4	Encel.	sf.
	23·0	Tethys.	nf.
	0·7	Dione.	inf. 8″ s.
	3·8	Encel.	sp.
	4·5	Dione.	sp.
	6·6	Titan.	sup. 26″ n.
29	19·1	Mimas.	e.
	20·3	Encel.	nf.
	21·7	Tethys.	sp.
	1·4	Encel.	e.
	5·6	Tethys.	w.
	5·7	Dione.	np.
30	20·4	Tethys.	nf.
	22·9	Encel.	np.
	2·1	Dione.	e.
	4·3	Tethys.	e.
	5·1	Mimas.	w.
	5·3	Encel.	nf.
Dec. 1	18·5	Dione.	inf. 8″ s.
	19·2	Tethys.	sp.
	21·8	Encel.	sp.
	22·4	Dione.	sp.
	2·9	Encel.	w.
	3·0	Tethys.	w.
	3·8	Mimas.	w.
2	18·4	Rhea.	inf. 12″ s.
	19·3	Encel.	e.
?	22·3	Iapetus.	sup. 10″ s.

This is the last chance which observers will have for more than a dozen years, of observing a close conjunction of Iapetus with the centre of Saturn. Will it be allowed to slip away without being taken advantage of?

The semi-axes of the apparent orbits of the five inner satellites, and of the outer rim of the ring, expressed in semi-diameters of the ball's equator, may be taken to be

	Ring.	Mimas.	Encel.	Tethys.	Dione.	Rhea.
Semi-major axis	2·31	3·14	4·03	4·99	6·40	8·93
Semi-minor axis.						
Nov. 1	0·37	0·51	0·65	0·81	1·04	1·45
11	0·37	0·51	0·65	0·81	1·03	1·44
21	0·37	0·50	0·64	0·80	1·02	1·42
Dec. 1	0·36	0·49	0·63	0·78	1·00	1·39

the polar semi-diameter of the ball being 0·90.

If these apparent orbits are laid down graphically, and the points of the major-axes at the corresponding distances from the centre are marked 3, 4, 5, etc., approximate positions of the satellite may be estimated with the help of the previous list of conjunctions and elongations, since Enceladus will be found opposite the point 3 about 3·8 hours before and after its greatest elongation.

			h.	
Tethys opposite point	3	about	1·2	*Before* the conjunctions marked "np." and "sf." and *After* the conjunctions marked "nf." and "sp." in the previous list.
	4	"	3·2	
Dione " "	3	"	1·3	
	4	"	3·2	
	5	"	5·5	
Rhea " "	3	"	1·4	
	4	"	3·5	
	5	"	5·8	
	6	"	8·2	
	7	"	11·1	
	7	"	11·6	Before & after its greatest elong.
	8	"	8·0	" " "
Dione " "	6	"	3·7	" " "

Elongations l of the five inner satellites for 0h. Gr. Sid. T., of every fifth day, expressed in decimal fractions of a revolution.

1876.	Mimas.		Encel.		Tethys.		Dione.		Rhea.	
Nov.	l.	diff.	l.	diff.	l.	diff.	l.	diff.	l.	diff.
1	·841	5·291	·832	3·639	·838	2·641	·654	1·822	·710	1·103
6	·132	5·290	·471	"	·479	"	·476	1·821	·813	1·104
11	·422	"	·110	3·638	·120	"	·297	1·822	·917	"
16	·712	"	·748	3·639	·761	"	·119	1·821	·021	1·103
21	·002	"	·387	3·638	·402	2·640	·940	"	·124	"
26	·292	5·291	·025	"	·042	"	·761	"	·227	"
Dec.										
1	·583		·663		·682		·582		·330	

These values must be interpolated for the times for which the places of the satellites are required, which may easily be done with the help of the tables at page 252, when the co-ordinates x may be found in the table at the bottom of page 252 and beginning of 253.

If l. is between ·000 and ·250 the satellite is on the following side, n. of ring.
·250 " ·500 " " " " s. "
·500 " ·750 " " preceding " s. "
·750 " ·000 " " " " n. "

Differences of right ascension and declination of Titan and Iapetus and of the centre of Saturn. At 0h. Gr. Sid. Time.

		Titan.		Iapetus.	
		α—A.	δ—D.	α—A.	δ—D.
1876.		s.	"	s.	"
Nov.	1	+12·20	—25·2	—25·94	—10·0
	2	10·16	32·3	27·76	11·6
	3	6·71	34·8	29·41	13·2
	4	+2·32	32·4	30·88	14·7
	5	—2·40	25·2	32·17	16·1
	6	6·73	14·4	33·27	17·4
	7	10·00	— 1·4	34·17	18·6
	8	11·67	+11·8	34·86	19·7
	9	11·43	23·0	35·34	20·6
	10	9·29	30·3	35·61	21·5
	11	5·63	32·6	35·67	22·2
	12	—1·06	29·5	35·51	22·8

Nov.	13	+3·67	21·8	35·13	23·3
	14	7·82	+10.7	34·55	23·7
	15	10·79	− 1·9	33·76	23·9
	16	12.20	14·2	32·76	24·0
	17	11.87	24·4	31·56	23·9
	18	9·88	31·2	30·17	23·7
	19	6·52	33·5	28·59	23·4
	20	+2·25	31·1	26·84	23·0
	21	−2·33	24·1	24·93	22·4
	22	6·54	13·7	22·86	21·7
	23	9·72	− 1·1	20·66	20·8
	24	11·35	+11·5	18·33	19·8
	25	11·12	22·1	15·89	18·8
	26	9·05	29·1	13·36	17·6
	27	5·50	31·1	10·75	16·3
	28	−1·07	28·1	8·08	14·9
	29	+3.53	20·6	5·37	13·4
	30	7·56	+10·0	− 2·63	11·8
Dec.	1	10·47	− 2·0	+ 0·11	10·1
	2	11·85	13·7	2·84	8·3
	3	+11·56	−23·3	+ 5·55	− 6·5

A. M.

Errata in October number.—Page 241, line 5 from bottom, for *on* read *or;* page 242, line 1, for *lines* read *times;* page 242, line 3, for *line* read *time;* page 246, in the occultation and reappearance of 17 Tauri, for 5.39, 6.20, read 8.44 and 9 32.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To June, 1876.
Linwood, Rev. W.

To Sept., 1876.
Elliott, R.
Lawton, W.
Lean, W. S.
London Institution.
Potter, T., Jun.

To Dec., 1876.
Richards, Rev. W. J. B.
Sargent, Rev. J. P.

To March, 1877.
Lewis, H. K.

TO CORRESPONDENTS.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to JOHN C. JACKSON, at Lower Clapton, London, E.

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The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Rev. J. C. JACKSON, *Clarence Road, Clapton, E.*, **not later than the 15th of the Month.**

The Astronomical Register.

No. 168. DECEMBER. 1876.

ROYAL ASTRONOMICAL SOCIETY.

Session 1876—77.
First Meeting after the Long Vacation, November 10th, 1876.
William Huggins, Esq., D.C.L., LL.D., &c., *President*, in the Chair.
Secretaries—Mr. Dunkin and Mr. Ranyard.

The minutes of the preceding Meeting were read and confirmed.

Mr. Ranyard reported that 133 presents had been received by the Society since their last meeting in June. Amongst these was a complete set of the Transactions and Proceedings of the Finnish Society, which had been presented by Prof. Krueger, of Helsingfors, and two volumes of Argelander's Abo Observations, also a beautifully finished drawing by Prof. Temple, of Florence, of the Great Nebula in Orion, and an oil picture, by a Spanish artist, representing the appearance of the sky and sea during the total solar eclipse of December 22nd, 1870. The studio window, from which the picture was taken, looked out to sea towards the north, and consequently the eclipsed sun is not seen in the picture, but is supposed to be at the back of the observer. No light is seen upon the horizon and the objects in the foreground appear dimly lit up. The thanks of the Society were formally voted to the donors of the presents.

The following candidates for the fellowship of the Society were balloted for and duly elected:

George Spedding Almond, Esq., Daisy Hill, Dewsbury.
Josiah Owen Corrie, Esq., B.A., Red Cot, Putney Park Lane.
Capt. Joseph Leeman, Aberdeen, and
Herbert Sadler, Esq., Honiton Rectory, Devonshire.

The President: The meeting will be glad to hear that the Astronomer-Royal has a communication to make to us to-night.

Sir G. B. Airy: At two or three of the first meetings of the Society in recent Sessions the President has intimated that he thought it desirable that I should make a report on what has been going on at the Observatory during the vacation. With regard to the general proceedings of the Royal Observatory—they have gone on in the usual way, with great strictness and severity. I declare that upon looking over the observations of the moon taken at the observatory during that severe part of the lunation which we know as the "old moon," the morning moon, I have been most surprised at the regularity with which the observations have been kept up. Nothing I could say would exceed the value I put upon that regularity, and on the zeal of the assistants at the observatory, who have been engaged on this severe duty. (Hear, hear). In the next place we have been prosecuting also an arduous task under the direction of my Chief Assistant, Mr. Christie,—we have been prosecuting the observations which were first urged upon us by Mr. De la Rue, connected with spectroscopy and photography of the sun, and I trust that the observations so made will be found to be very valuable: and we have also been attending to the important deductions from observations which you, Mr. President, initiated in this country. As regards another subject, it is well-known to the members of the Society that I have myself been engaged, with proper assistants, upon a novel form of the lunar theory—a numerical lunar theory; the work has been going on and I have brought with me on the present occasion some sheets to illustrate my practical view of the matter. It is very important that nothing should be lost of what we have done; and to provide against any contingency, I have endeavoured to preserve our work as far as we have gone by way of printing.

The Astronomer-Royal then showed six sheets of numerical formulæ, all of which related to expressions for the perturbations of the moon that occur parallel to the plane of the ecliptic; accompanied with others relating to perturbations normal to that plane, and proceeded to explain that each number exhibited on the sheets had been the result of numerous other numbers produced by multiplication and then added together; in some instances between twenty and thirty. He added: the Society will, I think, say that I have done well in providing against contingencies and avoiding risk so far as I can, in order that the labour so far as it has gone shall not be lost—by printing. (Hear, hear.) After this there follow certain matters which will not be thoroughly understood except by persons who have entered very minutely into these

questions, and especially who have entered into my views of the mode of dealing with the lunar theory. The great and leading principle is that every co-efficient amongst these is supposed to be affected by an error, unknown at present, but which I trust we shall make out fully in the long run. I trust that a great part of this theory, to which I attach some importance, is made secure. That part of it not fully completed at the present time, and not exhibited in print, is yet at the present time far advanced. I am very happy to say my plan is known in some measure to Professor Adams, and there can be no better judge of the value of the mode of treating it. (Hear, hear.)

The President: You have already anticipated the duty which falls upon me, to ask you to return your thanks to the Astronomer-Royal. (Hear, hear.)

Mr. Dunkin: The first paper is the one which I have had longest on hand, and which ought, therefore, to be read first. It has been in my hands three or four months, but as there has been no meeting of the Society it has been obliged to be deferred till now. It is by Professor Langley, of the Allegany Observatory, Pennsylvania, entitled *Measurements of the direct effects of the sun's spots on terrestrial climates.*

Since the question of the influence of solar changes on terrestrial climates was opened by the elder Herschel, a great number of observations have been compiled without any result, and the evidence appears to be different according to the interpretation of the compiler. But if we limit our inquiry to the direct effect of the sun spots upon the heat radiated, it appears that it may be possible to say by how many degrees or parts of a degree the annual temperature will vary between a year of maximum and a year of minimum spot areas. To do this it was necessary to procure trustworthy measurements of the relative amounts of heat radiated by a sun spot and an equal area of photosphere, and, secondly, to obtain the relative proportion of photospheric and spot surfaces at the different periods. And having done this, we can estimate within what specific limits we can assert that the terrestrial temperature will necessarily be changed.

Professor Langley had therefore, in the first instance, instituted experiments to determine the difference of the heat radiated by a unit of area of sunspot umbra, a unit of area of sunspot penumbra, and a unit of area of the photosphere. He had then made use of these estimates to determine the difference in the amount of the total solar radiation which might be expected in a year of maximum sunspot frequency and in a year of minimum sunspot frequency, For this purpose he had made use of the estimates of sunspot area arrived at by Schwabe, Carrington, De la Rue,

Balfour Stewart, and Loewy, and the general result which he arrived at was that the total difference of radiation would amount to only ·0009 of the total radiation, and the whole effect upon terrestrial temperatnre would, at most, be represented by a difference not exceeding three-tenths, and not less than one-twentieth, of 1° centigrade. A great part of the paper was devoted to a description of the methods he had employed in determining the difference of the heat radiated by an area of the umbra, and an equal area of photosphere. A galvanic pile was inclosed in a darkened chamber, kept at a constant temperature by hot-water receptacles; and the pile was carefully screened, so that small areas of the sun's disc could be thrown upon it, while it was, at the same time, screened from varying radiation in all other directions. The estimates given in the paper were deduced from 36 measures of the differences of umbral radiation and photospheric radiation, and from 32 measures of the differences of penumbral radiation and photospheric radiation made in the autumn of 1874 and the beginning of 1875.

Captain Noble: Does Professor Langley give in his paper the mode by which he obtained the mean temperature of the earth at the various periods? for as far as local temperature is concerned, I don't suppose we have had a hotter summer than we have experienced in England during this year, which it will be remembered has been a year of sunspot minimum, for many days the sun having been absolutely free from spots, and I am therefore curious to learn how he got at the mean temperature of the earth—whether he took the mean temperature of England, or North or South America, or where.

Mr. Dunkin: Captain Noble must bear in mind that this paper was written long before the hot weather set in. (Laughter.)

Sir G. B. Airy: The suggestions made in this paper are really of a very important nature. Some of the observations that were initiated at the Paris Observatory and have been followed by the Observatories of Edinburgh and Greenwich, may perhaps throw some light on this subject. It is well known that we have had for many years thermometers sunk in the soil at different depths, namely, at 3-ft. French measure, 6-ft., 12-ft., and 24-ft. I am not sure whether these were the best distances that could have been chosen, but those are the depths adopted, because they were adopted at the Paris Observatory in the first instance. The discussion of the observations made at the various Observatories has given a definite law of progression of temperature, its changes decreasing with the depth from the surface of the earth to the depth of 24 French feet, which may be said approximately to be 25 English feet. The result of the discussion is thus :—That

the temperature travels downwards, and that the summer of the surface is felt at a depth of 25 feet or thereabouts, long after the summer is over. So that the depth of winter in these lower regions occurs in the month of May. This is established perfectly well, and has been thoroughly discussed, and the rapidity of the progression is well understood. There is another circumstance connected with this; and although the materials for it existed perfectly in other places, yet I think is has not been brought to our knowledge till within the last few years or thereabouts, by myself, in examining the extensive series of observations made at Greenwich; it is this:—That in different years there is considerable difference in the temperature of the surface of the ground. When I say considerable, I mean six degrees of Fahrenheit, which is a quantity far beyond any possibility of error in determining the mean temperature of the year. When we trace the temperature downwards, corrected by the law of the decrease of temperature which I have spoken of, and which has been ascertained mainly by comparing one half of the year with another half of the same year, and so on—when we examine the decreasing temperatures through the course of a year, beginning the year at different times for the different depths according to the law of the propagation of temperature which has been ascertained from the half-yearly division of the observations of temperature—when we do that we find then that the year's temperature goes on approaching to an almost definite value, till at last the variations sink to nothing. Where we begin with a difference of six degrees between two years at the surface, that difference goes on decreasing gradually in the course of the year, and at the end of the year it still exists, but almost insensibly. Well, now, the inference from this is, that most certainly the changes that are to be observed in the temperature of the external surface of the earth do not come from the inside, but come from outside, because they go on diminishing as they go from the surface downwards till we come to localities where the temperature is about 47 Fahrenheit (but I do not speak from the book as to the exact figure)—we come to a temperature which is sensibly uniform between one year and another, although at the same time the mean temperature at the surface throughout the year from one year to another has varied as much as six degrees. Now, I think this leads to a very important cosmical fact indeed,—whether our temperature comes from the sun or something else external to it I will not venture to say,—but this I will venture to say, that our changes of temperature, as far as we have been able to observe them from year to year, come from something not internal but external. But then, on the other hand, we have evidence conflicting with that. I cannot say

that we know of a change coming from within, because I do not think any such have been sufficiently observed; but in different places, not only near to volcanoes, but in mines and other places not far removed from us, the temperature is considerably above that of the surrounding strata. At the Wheal Clifford mine, in Cornwall, I have walked at the depth of 1,400 feet in water which was really scalding my legs; and everybody who has been at Naples knows of similar facts. I have thrust my arm through sea water into the sand and found it was so burning hot that I was glad to get it out again. There are exceptions to the rule that all heating comes from the outside, and we seem to have the strangest medley of evident variations of heat from the outside and from the inside that anybody can imagine. We all look upon it as a problem which is certainly not determined at the present time, and in all probability will remain undetermined. Confessing my ignorance, Sir, I will sit down. (Laughter.)

Mr. De la Rue: I have given some attention to the subject which has been brought forward by Professor Langley, and though I am not prepared at the present time to state fully my convictions on the subject, seeing that the work that I undertook some time ago at the request of the Royal Society is being done twice over, in consequence of some serious errors which were discovered in a paper in course of printing, which I suppressed. Yet there is one remark I wish to make, that undoubtedly the investigations of Professor Langley are of very great value, inasmuch as he is a man quite able to deal with such investigations with all the exactitude that is necessary. The investigations he has made of the differences of the radiant heat derived from sunspots and from the photosphere are of the greatest value; but it does not at all follow that the greatest amount of solar radiation takes place at the period when the spots are fewest. It is very possible that the greatest amount of solar radiation takes place at those periods when the greatest number of sunspots indicate periods of great solar activity. There can be no doubt, I think, that the periods of sunspots, or the periods of solar activity, must in a great measure periodically affect solar radiation, and if the solar radiation varies only $\frac{1}{10}$ of a degree it must have a very great effect on climatology. Hence it is very desirable that sunspot investigations should be continued through a very great number of years, and that they should be made at many localities on the surface of the globe in order that we may ensure records for every day of the year. Now the experience of the work at Kew is this:—that though one gets a greater number of observations than one would at first conceive possible in England, still there are lacunæ that it would be very desirable to fill up. I am

glad therefore that the Astronomer-Royal has taken up at the Royal Observatory the work commenced at Kew. It has been commenced in Australia, and I hope the day will come when it will be taken up in India. It is not sufficient for all the problems to be solved that solar photographs should be taken on the small scale necessary for a general observation of the spots and their position in order to determine the solar rotation and other subjects connected with the sun, but it is very essential that studies of the sun should be made photographically upon a large scale. I have shown years ago that it is quite possible to take solar photographs on a scale of 4 feet to the sun's diameter, and that is a desideratum that should not be lost sight of; and I hope the influence of the Royal Astronomical Society will be exerted to obtain from the Government such aid as is necessary to conduct the operations which are requisite to secure photography on a large scale, and which are quite beyond the powers of individual efforts to prosecute continuously.

Mr. Ranyard: The remark I was going to make has been partly anticipated by Mr. De la Rue. It seems from general reasoning probable that the sun's radiation will not so much depend upon the spottiness of its surface as upon other causes. It seems to me probable, indeed, that the total heat radiated by the sun will be greatest at a period of sunspot maximum, rather than at a period of sunspot minimum, as assumed by Professor Langley. It seems to be proved that at the periods of sunspot maximum the upward currents in the solar envelopes, which we observe as prominences, are most active, and it is evident that the matter which is brought from a lower level is much hotter and more luminous than that of the upper strata. The radiation from any area of the sun is no doubt compounded of the radiation from matter at very various levels, and if, during any period, the upward and downward disturbances are more active, thus bringing the hotter matter to the outside, it will no doubt cause the total radiation from the area to be increased. It seems, therefore, probable that at a time of sunspot maxima the total radiation from the sun will be increased to a far greater extent than it would be diminished by the absorption of the spot areas.

Sir G. B Airy: If I may be allowed to speak again I would say, alluding to the word "climatic" effect, used by Mr. De la Rue, that after making this discovery of the strange changes which have taken place in the temperature of the exterior surface of the earth, I entered into a correspondence with the Board of Trade, in order to obtain from them the variations in the amount of cereals grown in this country in the years to which the most

important changes apply. I got their returns for every year; and on looking at them I fixed upon wheat as the most suitable grain to make enquiries about, for the reason that here in England we are just, as I may say, in the border climate for the produce of wheat. There are other countries that produce wheat better than our own, but we produce it very well, and at a short distance further north they do not produce wheat at all. I thought it would be a critical grain for the estimation of the effects of the difference in temperature in the different years. Well, I am sorry to say that I was very much disappointed in the result; except in one case, and that was with reference to the year 1860, which, judged by the criterion of the temperature of the soil, was a bad one, and judged by the criterion of the amount of wheat produced, was also a bad one. In other cases there was something which seemed like indications of some connection, but they were not quite certain, and I have never dared to produce them as actual instances or as incontrovertible instances of the connection between the two things; but between 1860 and the year which preceded it and the year which followed it it seemed that there could be no doubt.

The Chairman: It now becomes my duty to ask the meeting to return their thanks to Professor Langley, and in doing so I think we must not lose sight altogether of the experimental facts which he has contributed to our knowledge in connection with this subject. He has given us more accurate measurements of the relative heats of the different parts of the sun's surface. These data will no doubt be of very great value. At all events, I think that more accurate knowledge of the relative heats radiated from the umbra and penumbra as compared with the surrounding solar surface may throw considerable light upon many questions which are still under discussion in solar physics.

Mr. Christie was called upon to read a paper entitled *On the effect of wear in the micrometer screws of the Greenwich transit circle*—he said—This is a paper on the inequality which has been found to arise from the effects of wear of the micrometer screws of the Greenwich transit circle microscopes. The point to which I chiefly wish to draw attention is, that however perfect micrometer screws may be when they are received from the maker's hands, they must not be trusted after they have been in use for many years. It will be seen that if the spring which is always used to counteract the screw is always acting in one direction, it will cause wear in that direction, and the screws will get worn in the part where they are most frequently used more than in any other. The consequence is that an error may be produced which may sensibly affect a large number of observations in a systematic

manner. In the case of the microscopes at Greenwich, this effect was found out by the repetitions of observations of the Nadir point. They were always made with the same part of the circle, but when the change was made at the part of the screws at which the division was bisected, it was found there was a corresponding change in the Nadir point resulting. This threw a suspicion on the micrometer screws, and on examining them certain errors were found. They were afterwards compared by supplementary microscopes which had been very little used, and it was found there were large discordances, ranging from $-1''\cdot4$ to $+0''\cdot8$, which are large quantities in these matters. The question arose how long these errors had existed. This was an important matter, because it affected all the observations of stars which had been made at Greenwich for a number of years. It was found that in 1868 considerable wear had already taken place, and the corrections applicable were sensibly the same as in 1875, except for one part of the screw near the 0 revolution. This seemed rather puzzling, but it was explained by the circumstance that the practice had been commenced in that year of taking the Nadir point observation about the 0 revolution, and, therefore, that part of the screws had been more worn, and as the observations were taken twice a day the two curves showed a discordance at that part, at least, that is the only explanation I can give. My main point is to show that however many observations we may make of any one star, we cannot trust our result beyond a certain point, and must make allowance for certain systematic errors which may be of considerable amount.

Mr. De la Rue: It occurs to me that in observations it would, perhaps, be well if we had appended to circles, besides the ordinary screw micrometer, some contrivance in the nature of a vernier with microscopes magnifying sufficiently. It is obvious a vernier is not likely to be affected by wear, and comparison from time to time with the micrometers in common use might afford facilities for determining the errors of the microscopes. I may mention, for example, that in the micrometer which is used for measuring the solar photograms I abandoned the screw entirely in the construction of the instrument, and the measurements are made by means of a vernier.

Mr. Christie: The effect of any error from wear of the screws might be eliminated by making the microscopes in pairs, and reading in opposite directions; or with the spring acting in opposite directions, so that in one case you would have the reading increasing towards the head, and in the other microscope of the pair the reading increasing from the head; in that way the

effect would be practically eliminated, and would only be shown by the discordance between the two microscope readings.

Mr. Ranyard: Assuming that the wear was perfectly equal in either case.

Mr. Christie: Yes, practically it would be so.

Sir G. B. Airy: I think this is a remarkable instance of the doctrine I have always upheld, that things will never get right till they have gone wretchedly wrong. (Laughter.) There is a good chance now that an effort will be made to set them to rights. It so happened in this instance we were able, but with very great labour, to set things right by having a number of supplementary microscopes which were not made for this purpose; although I really think if we were making a new transit-circle we should make supplementary microscopes expressly for this purpose, but those which we have were made for examining the divisions of the circle. We declined, on principle, to trust to Mr. Simms or anybody else for the accuracy of our divisions, and we determined to establish such a series of microscopes upon the circle that we could answer ourselves for the accuracy of the divisions as they came into our hands. I advert to this only to explain that these supplementary microscopes, which had been established for a totally different purpose, came in, in a most felicitous way, for the difficulty which presented itself, and which it really seemed, if we had not had them, might have been insuperable. Now, in ordinary cases where microscopes are not provided for such a purpose, the best advice I can offer to people possessing instruments is, to do with regard to their microscopes, what they would do with other old things, namely, to have new ones, and to have them periodically and not wait till the old instruments are worn out, but have new micrometer screws from time to time. That I believe is the only principle on which observations can be continuous for any length of time.

Mr. Penrose was then called upon to read a paper entitled *An endeavour to simplify the method of making the correction for the spheroidal figure of the earth in lunar observations, and particularly with reference to the effect upon the lunar distance.* He argued that this correction was too important to be generally neglected, as it might occasionally affect the longitude by as much as a quarter of a degree. He showed how a graphic method might be made use of for close approximation to the required correction, and illustrated the method by an example worked upon a diagram which he had prepared.

Mr. Dunkin: I think we ought to be much obliged to Mr. Penrose for this paper, because his graphic method is likely to be important. But I rise principally to say that the method is

not new. I have already told Mr. Penrose so. Thirty years ago, when the altazimuth was erected, the Astronomer-Royal fixed upon this plan for the reduction of all observations made with it; that is to say, the observations of the moon were referred to the foot of the normal instead of to the centre of the earth. The method has been in use at the Royal Observatory for the last thirty years. With regard to its application to the clearing of the lunar distance the graphical method may be of use and of great value, and we are obliged to Mr. Penrose for the very careful and elaborate diagram which he has drawn by which we can determine the corrections merely by measuring them off. If that can be done as rapidly as Mr. Penrose assures me, I think it will be a very good plan to adopt for the reduction of the lunar distances. I have myself before now had considerable experience in the reduction of lunar distances by the ordinary methods, and if I could have found out the way to do it in the short time that Mr. Penrose states, it would not only have saved me trouble, but very likely improved the observations, because of course, in my reductions, I merely followed the ordinary rules of clearing the distance.

Mr. Marth: I may, perhaps, be allowed to make some remarks on the history of the subject, and to mention, that the proposed method of taking the ellipticity of the earth into account was introduced by Bessel in 1831, when he took up the question of lunar distances, and treated it with his usual thoroughness. Being dissatisfied with the incorrect results of the ordinary methods of computing lunar distances, he investigated the problem anew—considered the different sources of inaccuracy, amongst which was the neglect of the earth's ellipticity, and proposed a new method which should give correct results. The comparison of the amount of labour, which the new method demanded of the computer, with that demanded by the old inaccurate methods showed only a slight advantage in favour of the latter; but there was this serious drawback, that the new form of ephemeris required far more space than the old one, and it became then a question, whether the old form, notwithstanding its shortcomings, was or was not sufficient for ordinary practical purposes, a question which Bessel left to the decision of nautical men. At that time the *Nautical Almanac* in its greatly improved form was in preparation, and Baily and others considered the question, but thought it better not to make any alteration. Schumacher, however, undertook to publish ephemerides of the lunar distances from the sun and planets according to Bessel's method for the Danish Admiralty, and it was settled that the English Admiralty should take a number of copies from

Copenhagen and supply them to their ships, and see whether the officers would be sufficiently interested to use them. It turned out, however, that the naval officers of that time, with few exceptions, did not trouble themselves much about lunar distances, and, indeed, spoke rather slightingly of them. The Copenhagen ephemerides were published for some years, from 1835 to '38, but as they were little used, the publication was then stopped. Now, as Mr. Dunkin stated, the method of taking the ellipticity of the earth into account by referring the moon's place to the centre of the normal, has been used in the reductions of the altazimuth observations for nearly thirty years. When I first read that it had been brought before the Board of Visitors, I think in 1847, as a new method, I own I was very much surprised to learn that not one of the members of the Board had pointed out at once that there was nothing new in it, but that the method was well known to astronomers. But the strangest part of the affair is, that all the while and for a good many years afterwards there have been regularly advertised among the Admiralty publications "Auxiliary tables for Bessel's method of clearing the lunar distances," or some such title. Whether any copies of these tables were sold I do not know, but I am pretty sure that up to 1865 or thereabouts they were at least regularly advertised. Now, Mr. Penrose may well be excused for not knowing that his proposal of taking the earth's ellipticity into account is by no means a new one, since, in 1849, the officers and advisers of the Admiralty and the members of the Board of Visitors did not know better, notwithstanding the advertisements of the Admiralty publications. As the question has come up, it is only fair that the history of it should not be forgotten, and I hope, therefore, you will not object to my having mentioned some of the circumstances connected with it. Bessel's investigation, which is well worth studying independently of its practical purpose, is to be found in the *Astronomische Nachrichten,* and also, with some alterations, in his *Astronomische Untersuchungen.*

The President: We are obliged to Mr. Marth for calling our attention to the history of the subject. It is an old proverb that there is nothing new under the sun, but still the beautiful things the sun brings out of the earth are not the less welcome to us because they have appeared before. I think in this case we ought to be much obliged to Mr. Penrose for calling public attention to a method which in the form presented to us may practically be said to have been brought forward for the first time.

Mr. Dunkin: It has been explained in the introduction to the Greenwich observations every year since 1847.

The President: I mean as combined with the graphical method.

Mr. Thornthwaite was called upon to describe a binocular eye-piece, which he exhibited to the meeting. The eyes, he said, were greatly relieved by making use of such an eye-piece, and the appearance of rotundity which telescopic objects assumed was very pleasing; the effect must be seen to be appreciated.

The President, in thanking Mr. Thornthwaite for his communication, said, I can corroborate what he has stated as to the apparent solidity of some heavenly bodies when viewed with two eyes.

Mr. Christie: I may mention that we have some spectroscopic observations that have been made recently at Greenwich. The chief point of interest in the matter is that we have gone on with the star observations, but we have also some further observations in the cases where the motion is already known; which have been made in consequence of doubts expressed as to the theory of the displacement of the lines. In particular we have made observations of the displacement of the lines of Venus, caused by its approach and recession before and after conjunction. They agreed fairly well with theory. We have also made measures of the rotation of the sun and of Jupiter, as determined by the displacement of the lines at the east and west limbs. Certain precautions have been adopted which are more fully explained in the paper, and I hope they will be found to be satisfactory. It must be understood that these are very delicate measures, and everything depends on adopting precautions which will get rid of certain sources of error, such as the heat of the sun in measuring the rotation of the sun. I wish also to say that I have made some observations on the point to which Mr. Brett has called attention—I mean the gradation of light on the disc of Venus. Mr. Brett first pointed out that the brightness adjacent to the limb is not so intense as towards the central portions between the limb and the terminator when Venus is gibbous. It is well established, I think, that there is a considerable gradation towards the terminator, but the chief question at issue is whether there is any gradation towards the limb or not. Mr. Brett, from very careful eye comparisons, found that there was a gradation towards the limb. Capt. Noble disputes this, having made observations with a dark wedge. I have examined Venus by means of my polarising eye-piece, in which the light is enfeebled by reflection, first of all at three surfaces of glass and then again by polarising with a Nicol's prism. As I turned the Nicol I found that the form at last became sausage-shaped, and the only point to make sure of was whether the convex edge of the sausage-shaped area coincides with the limb, or is distinctly within it. I think that probably Capt. Noble confounded this outer edge with the limb of the planet, and I

have therefore made some careful comparisons, and have satisfied myself that this edge does not coincide with the limb, but is about $\frac{1}{8}$th of the radius from the limb itself. I conclude from the position of the Nicol that the brightness of the central portion was about five times as great as that of the part near the limb. I took particular care in making my comparisons, and I do not think I could be deceived. When the light was reduced by the solar eye-piece, I perceived a distinct gradation towards the limb. Using the solar eye-piece without the prism the light was reduced about $\frac{1}{3000}$th part. When the light towards the terminator disappeared the planet became almost crescent-shaped, and its light about $\frac{1}{27000}$th part, when the sausage-shaped area disappeared altogether it was reduced to about $\frac{1}{135000}$th part. I only call attention to this as a point to be examined carefully. I think it is well worth further investigation.

Capt. Noble: Did the sausage-shaped area go out all at once?

Mr. Christie: Practically it does.

Mr. Ranyard asked Mr. Christie whether he had made any experiments to determine whether the light of Venus, or the sausage-shaped area he described, was polarised, as it undoubtedly would be if the brighter area were due to specular reflection, as suggested by Mr. Brett?

Mr. Christie said that he had not made any such experiments, but that his polarising apparatus was only made use of in order to gradually reduce the intensity of the light, His chief point was that a gradation of light was to be found both towards the limb and the terminator.

Mr. De la Rue: Gradations of light might be referable to markings on Venus's disc.

Mr. Christie: I have tried to find markings a good many times and I have not been able to discover any. I do not mean to say that no markings exist; but I do not think that they existed at the time I looked at the planet.

Mr. De la Rue: I have never looked at Venus without seeing configurations reminding me of the configurations of Mars. If this difference is referable to the configurations or markings of Venus, it would give us the time of the rotation of Venus on its axis.

Mr. Christie: I have never been able to fix any markings positively. I have fancied that I saw them, and sometimes I have fancied one part of the disc was brighter than the other, and it has always given me the impression of being slightly mottled; but I find generally, that these apparent irregularities in the brightness and especially the peculiar shape of the cusps, are referable to atmospheric tremors. I find that that is a distinct effect of atmospheric tremor.

Mr. Bidder here endeavoured to explain how the bright patch described by Mr. Christie might be the result of specular reflection from the body of Venus, and it was explained by the President that Mr. Brett had originally made the same suggestion.

Mr. Christie: I ought to say that these observations as well as the spectroscopic observations of Venus were made in the day time. Observations of Venus of this character can be made better just now in the day than in the evening; but the matter will be tested more readily as Venus gets nearer to superior conjunction.

Mr. Ranyard said that he thought that it was not necessary to assume that there was specular reflection from the body of Venus in order to account for the gradations of brightness which had been described by Mr. Christie, If Venus has a very dense atmosphere, we should expect to find the light from the body of the planet partly absorbed near the limb, the light from near the terminator would also be weakened, and there would remain just the sausage-shaped brighter area described. Soon after Captain Noble had described his experiment with the dark wedge, he had examined Venus with a telescope and bi-quartz polariscope, but he had not been able to discover the slightest trace of colour. And another point which weighed against the specular reflection theory was that the brighter patch ought, if it was due to specular reflection of the sun's light, to be circular, and not sausage-shaped, as described.

The following papers were also taken as read :—

Dr. Copeland: *Observations of planets with the transit circle at Dunsink* (Dublin).

A. T. Arcimis : *Observations of lunar eclipse*, 1876, *September* 3, *made at Cadiz.*

W. H. Finlay: *A method of deducing the formula for correcting the computed time of an observed occultation for errors in the elements adopted.*

The Meeting adjourned at ten o'clock.

REVIEW.

On ω Leonis considered as a Revolving Double Star. By W. Doberck, Ph. D., M.R.S.A., Astronomer at Markree Observatory. From the Transactions of the Royal Irish Academy, Volume xxvi. Dublin.

Previous papers by Dr. Doberck have appeared in these Transactions. Vol. xxv. part 13, *On μ^2 Boötis (as a revolving double star).* Part 19, *On the Binary Stars σ Coronæ, τ Ophiuchi, γ Leonis, ζ Aquarii,* 36 *Andromedæ, and i Leonis.* Vol. xxvi. part 1, *On the Binary Stars* 44 *Boötis, η Cassiopeiæ and μ Draconis, with addenda to previous memoirs.* Dr. Doberck is a member of the International Astronomical Society, and Astronomer at

Colonel Cooper's Observatory, Markree, Co. Sligo, (the price to the public of each of these parts is 1s. They are sold at the Academy House, and by Williams & Norgate, 14, Henrietta Street, Covent Garden, London). The present paper was read April 10th, 1876.

"ω Leonis," says Dr. Doberck, "is one of the most remarkable of the double stars which were discovered by Sir William Herschel. Its excessive closeness renders it one of the most difficult objects in the heavens; wherefore large discrepancies between the measures, especially in those taken with smaller instruments, occur; but it has, notwithstanding, been well watched by observers, especially since W. Struve commenced his Dorpat observations." O. Struve believed that the distance of the centres in 1840 and 1842 did not amount to 0·″30. The larger star is about the sixth magnitude, the companion of the seventh. "Different astronomers have calculated elements of this star, whose binary character did not fail soon to be established, but it has been scrutinized by nobody so often as by Professor Klinkerfues, the successor of Gauss in Göttingen." Dr. Doberck gives three different sets of elements, obtained at different times and in different ways by Klinkerfues, and then describes his own investigations, and gives tables of four successive orbital determinations. Table viii. is a comparison of the observations of ω Leonis with the ephemeris calculated after the fourth set of elements. These observations, made by sixteen astronomers, commence with W. Herschel in 1782, and end with Duner in 1875. The author then describes his method of obtaining a still better orbit, the elements of which he presents as follows:—Long. of node, 148° 46′. Inclination, 64° 5′. Angle between periastion and node, 121° 4′. Excentricity, 0·5360. Period 110·82 years. Epoch of periastion passage, 1841·81. Semi-axis-major, or mean distance, 0″·890. These elements he considers definite until further observations under the now more favourable circumstances have been taken. In table xiii. these last elements are compared with numerous observations from W. Herschel to Gledhill, 1876, 20. In conclusion Dr. Doberck explains a method by which approximate elements of donble stars may be corrected.

The Markree observatory, as is well known, has done excellent work in past years. The above Memoir is a valuable contribution to the department of double stars; one well suited for the amateur who possesses a good telescope and micrometer. We should have liked to see a diagram of the orbit of ω Leonis, though the ellipse can of course be drawn from the data. Perhaps some day we may have something like a complete work in English on double stars, with all its binary systems whose orbits have been ascertained with more or less certainty. The new edition of *Smyth's Cycle*, which was mentioned by its regretted author as being in preparation by a friend in 1863, it seems as if we shall scarcely see before the Greek Kalends. This hope deferred must have made many a heart sick. We look forward with some impatience to the appearance of M. Flammarion's promised work (See *Astronomical Register*, March, p. 59). This astronomer has examined all the observations of double stars to the present time. The number of these systems, he says, both physical and optical, now amounts to above 10,600, and the number of observations to more than 200,000. He has reached results, from this labour, totally unexpected on the nature of these systems; some of which are orbital, others in rectilinear movement; some irregular in their movements, others fixed, &c.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

NEAR APPROACH OF VESTA.

Sir,—On looking at the places of Vesta in the *Nautical Almanac* for 1877, I see the planet appears to make a pretty near appulse to the moon on March 11. On a former occasion, December 30, 1871, there was an occultation of the planet. But this time, even if it should prove an occultation to any part of the world, it would not be visible here.

S. J. J.

ZODIACAL LIGHT.

Sir,—The phenomenon mentioned by H. Corder, on p. 267, is undoubtedly the Zodiacal light, which I believe on *every* really clear and dark night may be traced throughout the Zodiac, except where the milky way interferes with its visibility. Just opposite the sun a patch of greater brightness exists, which was discovered in 1854 by Brorsen, who called it the "Gegenschein." Your readers may have the next opportunity of observing this "counterglow" in February, when it will have emerged from the milky way. Though discovered so long since, these phenomena seem very little known; probably on account of being easily seen only by eyes accustomed to observe similar objects. To my eyes now, however, the "counterglow" is conspicuous, and the rest of the circle of the Zodiacal light quite plain.

T. W. BACKHOUSE.

Sunderland: 17th Nov., 1876.

OCTOBER SHOOTING STARS.

Sir,—Mr. H. Corder (*Register* p. 267) mentions that on October 13, 9h. to 11h., he saw 14 small meteors, "most of them appearing to come from a large area of radiation, comprising Aries, Triangulum, and part of Perseus." The fact is that in this immediate region there are several active radiants traceable with difficulty, unless the paths are carefully mapped down as observed. Relying upon eye estimates and memory these radiants lying so close together, are apt to be confused. I was on the look out during the same time as your correspondent, and saw 19 small meteors in 3½ hours, chiefly from Cassiopeia; others came from radiants included in the region mentioned by him, for position of which see Nos. 1, 4, and 13 in the list of 16 radiants given below. On Sept. 21, Mr. Corder also records that he counted 43 small meteors between 8·15, and 11. I found them scarce at the same time and date, but on the preceding night they were frequent, 8 being recorded in the 10 minutes 9·44 to 9·54, though less numerous before and after. Mr. Corder's radiant of 10 ("1° N. of the centre of a line joining α and γ Pegasi") at $352° + 15°$ is a confirmation of a well-known August and September shower at

352° +13°, which is a mean of 11 radiants by different observers. The other radiants mentioned by him (see Nos. 6, 13 and 14 in the list) as chiefly active, were also shown on September 20, and I can confirm him in this, though I saw nothing of the shower between α and γ Pegasi. The following table is a summary of my observations :—

September and October radiant points (deduced from 150 meteors)
Sept. 10—20 (28) and Oct. 13—29 (122), 1876.

No.	Dates, 1875.	Position of Radiant. in.	at. R.A.	Dec. N.	No. of Meteors.	Greg's. No. 1874.
			°	°		
1	Sept. 20—Oct. 25.	Musca ...	46	26	19	129
2	Sept. 18—Oct. 21.	Cassiopeia ...	14	50	13	173
3	Oct. 17—25.	Orion ...	88	17	8	157
4	Sept. 17—Oct. 21.	Pisces ...	15	11	14	195
5	Oct. 13—29.	Lynx ...	126	49	11	141
6	Sept. 17—Oct. 25.	Lacerta ...	317	57	10	130—144
7	Oct. 14—25.	Auriga ...	90	58	6	136
8	October 14—17.	Cetus ...	38	12	5	138
9	Oct. 13—25.	Camelopardus	48	71	7	193
10	Sept. 10—Oct. 21.	Andromeda ...	358	26	7	194
11	Sept. 17—20.	Cygnus ...	313	43	4	151
12	Sept. 20—Oct. 29.	Ursa Minor ...	161	84	7	128—143
13	Sept. 20—Oct. 19.	Triangulum ...	31	37	5	129
		Perseus ...	40	40	4	
14	Sept. 16—Oct 25.	Lacerta ...	346	44	6	160
15	Oct. 21—29.	Taurus ...	61	18	6	156
16	Oct. 25—29.	Gemini ...	109	23	6	142

12 meteors were not conformable to either of these radiants.

Notes.

1. An active radiant, well defined. Max. Oct. 14, 15.
2. Rather diffuse but active. Max. Oct. 13.
3. Meteors rapid with trains. Radiant, well defined.
4. An active radiant. Meteors very slow. Max. Oct. 21. This is a mean of two showers, 11 + 8 and 20 + 14.
5. Diffuse ; perhaps two showers in this region ?
6. Rather active. Meteors rapid, white and trainless. Mean of two feeble showers, 326 + 51 and 309 + 64.
7. Well marked, though somewhat inactive. Meteors rapid, trains.
8. A feeble shower. Meteors very slow ; perhaps confused with No. 4.
9. A continuation of a new radiant (Sept.) in Tarandus. Mean of two feeble showers, 32 + 70 and 65 + 71.
10. A feeble radiant near α Andromedæ. Max. Oct. 21. Gruber gives (1874) a new position at 2 + 25, which is no doubt identical with this.
11. A feeble continuation of the Cygnids. (Aug.)
12. Diffuse though marked radiant, giving very rapid white meteors.
13. These are probably the same = mean 35 + 38, quite distinct from the Muscids (No. 1), and same as G. 129, 36 + 35.
14. A feeble continuation of an August shower.
15. Somewhat inactive though a marked shower.
16. Meteors very rapid. Max. Oct. 30, a.m.

None of these positions are absolutely new, though No. 9 has not been

seen before in Oct. and No. 10 has only been detected by one foreign observer. The others are useful as confirming previous determinations, and this was much required in several cases. I have given the number of meteors from each shower as this is important, not only as showing the intensity, but as giving the probable value of the positions deduced.

I found meteors rather numerous in October. In twenty-three hours watching between 13th and 29th I saw 155 and recorded 122 of these. Subtracting two hours of moonlight (on the 25th, four meteors), and deducting one-sixth of the watch during which attention was engaged in mapping, temporary absence, &c., we get the horary number of 8·6 for Oct. 13—29. (one observer looking eastward, p.m.) But in the latter half of July and first half of August I found them equally numerous, even excluding the Perseids, for the Cassiopeids and Draconids were very active then.

I am, sir, your obedient servant,
W. F. DENNING.

Ashley Down, Bristol:
November 5th, 1876.

LUNAR OBJECTS SUITABLE FOR OBSERVATION IN DECEMBER, 1876.

By W. R. Birt, F.R.A.S., F.M.S.

In our List for October, p. 245, we noticed that Neison in Map XXII. gives a crater aligning with Rosse, the crater *b*, and the three peaked mountain XII. of the synopsis. This crater is situated between *b* and XII. (IV. B ρ 9) in a line with *b* and Rosse, nearly at right angles with the line from the shallow crater XI. to the mountain XXIII. of the synopsis—see List for November, p. 271. This line is continued through Fracastorius to the south border, through Nos. 4, 8, 27, 23, to 18 and 19 of Simms's sketches, who gives on his sketch of August 8, 1876, a crater chain or cleft from 27 to 7 which he marks 30. This crater chain is not one of those given by Ingall—*English Mechanic*, September 16, 1870, p. 602—but crosses the one from *a* to *b* in his diagram. That it is not Ingall's chain from *c* to *b* is clear, for a line along Ingall's chain cuts the ridge just within the south-west border of Fracastorius, while that along Simms's chain is inclined fully 40° to that along Ingall's; the question, therefore, arises, Did Ingall *miss* the chain seen by Simms more than six years later than Ingall's observation, or has there been an alteration in the disposition of these minute objects? Of course further observations are necessary to determine this point. Simms considers this chain to be the western part of Neison's rill ϕ, shewn by Gaudibert, *English Mechanic*, June 30, 1876, p. 405. Neison records this part of the cleft as discovered in 1873, and the eastern part by Gaudibert in 1874. Ingall's chain was seen in 1870. Gaudibert shows the cleft as running between the central mountain (undesignated by him) and Ingall's *c*, Neison (Map XIX.) shews it as just south of 9 or Ingall's *c*. After having crossed the cleft, the line from Rosse to the south border of Fracastorius on Gaudibert's sketch terminates with his object 22, which is undesignated by Neison.

ASTRONOMICAL OCCURRENCES FOR DECEMBER, 1876.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Alde-baran.
Fri	1	15 59	Near approach of B.A.C. 1648 (6½) Saturn's Ring: Major axis=38″·24 Minor axis=5″·96			11 44·2
Sat	2		Sidereal Time at Mean Noon, 16h. 46m. 40·09s.			11 40·3
Sun	3	19 32 20 11 23	Occultation of κ Geminorum (3½) Reappearance of ditto Superior conjunction of Mercury and Sun	Satellites of Jupiter invisible through his nearness to the Sun.		11 36·3
Mon	4	3 5	Conjunction of Jupiter and Sun Conjunction of Jupiter and Mercury, 1° 30′ S.			11 32·4
Tues	5		Sun's Meridian Passage 8m. 58·02s. before Mean Noon			11 28·5
Wed	6	17 19 18 15 19 25	Occultation of ρ Leonis (4) Reappearance of ditto Near approach of 49 Leonis (6)			11 24·5
Thur	7	14 23	☾ Moon's Last Quarter			11 20·6
Fri	8					11 16·7
Sat	9					11 12·7
Sun	10					11 8·8
Mon	11	16	Conjunction of Moon and Mars 5° 9′ N.			11 4·8
Tues	12	8	Conjunction of Moon and Venus 6° 40′ N.			11 0·9
Wed	13					10 57·0
Thur	14	14	Conjunction of Moon and Jupiter 5° 30′ N.			10 53·1
Fri	15	6 13 21	● New Moon Conjunction of Moon and Mercury 2° 51′ N. Illuminated portion of disc of Venus=0·820 Illuminated portion of disc of Mars=0·955			10 49·1
Sat	16					10 45·2
Sun	17		Sidereal Time at Mean Noon 17h. 45m. 49·33s.			10 41·3
Mon	18		Sun's Meridian Passage 2m. 53·34s. before Mean Noon			10 37·3
Tues	19					10 33·4
Wed	20					10 29·5

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Alde-baran.
Thur	21	8 29	Near approach of 64 Aquarii (6½)			—
			Conjunction of Moon and Saturn 0° 55′ S.			
			Saturn's Ring: Major axis=37″·04 Minor axis=5″·40			10 25·5
Fri	22	5 57	Near approach of 96 Aquarii (5½)			10 21·6
		7 32	Near approach of B.A.C. 8134 (6½)			
Sat	23	11 41	☽ Moon's First Quarter	Satellites of Jupiter invisible through his nearness to the Sun		10 17·7
Sun	24	5 4	Occultation of 60 Piscium (6)			10 13·7
		5 38	Reappearance of ditto			
		6 0	Occultation of 62 Piscium (6)			
		7 13	Reappearance of ditto			
		7 0	Occultation of δ Piscium (4½)			
		7 26	Reappearance of ditto			
Mon	25					10 9·8
Tues	26	9 10	Occultation of B.A.C. 782 (6½)			10 5·9
		9 53	Reappearance of ditto			
		13 55	Occultation of μ Arietis (5½)			
		14 41	Reappearance of ditto			
Wed	27	15 13	Occultation of 16 Tauri (5½)			10 2·0
		16 5	Reappearance of ditto			
		15 26	Occultation of 17 Tauri (4)			
		16 14	Reappearance of ditto			
		15 47	Occultation of 19 Tauri (5)			
		16 17	Reappearance of ditto			
		15 50	Occultation of 20 Tauri (5)			
		16 38	Reappearance of ditto			
		16 19	Near approach of 23 Tauri (5)			
		16 30	Occultation of η Tauri (3)			
		17 2	Reappearance of ditto			
		17 7	Occultation of 28 Tauri (5½)			
		17 19	Near approach of 27 Tauri (4)			
Thur	28	3 49	Occultation of χ^1 Tauri (5½)			9 58·1
		4 19	Reappearance of ditto			
Fri	29	6 16	Occultation of B.A.C. 1746 (6½)			9 54·1
		7 13	Reappearance of ditto			
		14 16	Occultation of 136 Tauri (5)			
		14 54	Reappearance of ditto			
Sat	30	9 58	○ Full Moon			9 50·2
Sun	31	44 1	Occultation reappearance of κ Geminorum (3½)			9 46·3

THE PLANETS FOR DECEMBER.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	16 31 12	S. 22 41	4″·6	23 44·6
	9th	17 18 42	S. 24 33½	4″·6	0 4·4
	17th	18 14 33	S. 25 24	4″·8	0 28·7
	25th	19 10 53	S. 24 39½	5″·1	0 53·4
Venus ...	1st	14 8 45	S. 10 52	13″·9	21 22·5
	9th	14 46 34	S. 14 2	13″·3	21 28·8
	17th	15 25 37	S. 16 53	12″·9	21 36·2
	25th	16 5 55	S. 19 16½	12″·5	21 45·0
Saturn ...	1st	22 18 38	S. 12 23½	15″·4	5 35·0
	9th	22 20 13	S. 12 13½	15″·1	5 5·1
	17th	22 22 9	S. 12 1½	14″·9	4 35·6
	25th	22 24 26	S. 11 48	14″·8	4 6·4
Neptune ...	2nd	2 5 29	N. 10 47½	...	9 17·3
	18th	2 4 24	N. 10 42½	...	8 13·3

Mercury sets close to the sun at the beginning of the month, but he may be observed towards the end of the month after sunset.

Venus rises about three hours and a half before the sun at the beginning of the month, the interval decreasing.

Saturn sets about an hour and a half before midnight at the beginning of the month, the interval increasing.

SATELLITES OF SATURN.

Approximate Greenwich sidereal times of conjunctions and greatest elongations occurring between 18h. and 6h. Greenwich sidereal time.

f. conj. with following edge of ring. n. north of ring.
p. „ „ preceding „ „ s. south „
sup. superior conj. with centre of ball. e. at greatest eastern elongation.
inf. inferior „ „ w. „ western „

1876.	Gr. Sid. Time.		
	h.		
Dec. 1	18·5	Dione.	inf. 8″ s.
	19·2	Tethys.	sp.
	21·8	Encel.	sp.
	22·4	Dione.	sp.
	2·9	Encel.	w.
	3·0	Tethys.	w.
	3·8	Mimas.	w.
2	18·4	Rhea.	inf. 12″ s.
	19·3	Encel.	e.
?	22·3	Iapetus.	sup. 10″ s.
	22·9	Rhea.	sp.
	23·6	Dione.	np.
	0·4	Encel.	sf.
	1·8	Tethys.	e.
	2·5	Mimas.	w.
3	20·0	Dione.	e.
	21·6	Rhea.	w.
	23·3	Encel.	nf.
	0·5	Tethys.	w.

1876.	Gr. Sid. Time.		
	h.		
	1·2	Mimas.	w.
	4·3	Encel.	e.
4	20·3	Rhea.	np.
	20·8	Encel.	w.
	23·2	Tethys.	e.
	23·8	Mimas.	w.
	0·8	Rhea.	sup. 11″ n.
	1·9	Encel.	np.
	4·9	Dione.	w.
	5·3	Rhea.	nf.
5	18·4	Encel.	sf.
	21·9	Tethys.	w.
	22·5	Mimas.	w.
	0·8	Encel.	sp.
	1·3	Dione.	nf.
	4·0	Rhea.	e.
	5·8	Encel.	w.
	5·8	Tethys.	np.
6	20·7	Tethys.	e.

1876.	Gr. Sid. Time. h.		
	21·2	Mimas.	w.
	22·3	Encel.	e.
	2·5	Dione.	sf.
	2·7	Rhea.	sf.
	3·3	Encel.	sf.
	4·6	Tethys.	sf.
	13·3	Titan.	inf. 26″ s.
7	19·4	Tethys.	w.
	19·8	Encel.	np.
	19·9	Mimas.	w.
	22·8	Dione.	w.
	2·2	Encel.	nf.
	3·3	Tethys.	np.
8	18·1	Tethys.	e.
	18·6	Mimas.	w.
	18·7	Encel.	sp.
	19·2	Dione.	nf.
	23.8	Encel.	w.
	2·0	Tethys.	sf.
	4·8	Encel.	np.
	5·9	Mimas.	e.
9	18·1	Rhea.	nf.
	20·4	Dione.	sf.
	21·3	Encel.	sf.
	0·2	Dione.	inf. 8″ s.
	0·7	Tethys.	nf.
	3·7	Encel.	sp.
	4·1	Dione.	sp.
	4·6	Mimas.	e.
10	20·2	Encel.	nf.
	23·4	Tethys.	nf.
	1·2	Encel.	e.
	3·3	Mimas	e.
	5·3	Dione.	np.
11	20·0	Rhea.	inf. 11″ s.
	22·2	Tethys.	np.
	22·8	Encel.	np.
	0·5	Rhea.	sp.
	1·7	Dione	e.
	2·0	Mimas.	e.
	5·1	Tethys.	nf.
	5·2	Encel.	nf.
12	18·1	Dione.	inf. 8″ s.
	20·9	Tethys.	sf.
	21·7	Encel.	sp.
	22·0	Dione.	sp.
	23·2	Rhea.	w.
	0·7	Mimas.	e.
	2·7	Encel.	w.
	3.8	Tethys.	sp.
13	19·2	Encel.	e.
	19·6	Tethys.	np.

1876.	Gr. Sid. Time. h.		
	21·9	Rhea.	np.
	23·2	Dione.	np.
	23·4	Mimas.	e.
	0·3	Encel.	sf.
	2·4	Rhea.	sup. 11″ n.
	2·6	Tethys.	nf.
14	18·3	Tethys.	sf.
	19·6	Dione.	e.
	22·0	Mimas.	e.
	23·2	Encel.	nf.
	1·3	Tethys.	sp.
	4·2	Encel.	e.
	5·6	Rhea.	e.
	7·2	Titan.	sup. 24″ n.
15	20·7	Encel.	w.
	20·7	Mimas.	e.
	0·0	Tethys.	nf.
	1·8	Encel.	np.
	4·3	Rhea.	sf.
	4·5	Dione.	w.
16	18·2	Encel.	sf.
	19·4	Mimas.	e.
	22·7	Tethys.	sp.
	0·6	Encel.	sp.
	0·9	Dione.	nf.
	5·7	Encel.	w.
17	18·1	Mimas.	e.
	21·5	Tethys.	nf.
	22·2	Encel.	e.
	2·1	Dione.	sf.
	3·2	Encel.	sf.
	5·4	Tethys.	e.
	5·4	Mimas.	w.
	5·9	Dione.	inf. 8″ s.
18	19·8	Rhea.	nf.
	20·2	Tethys.	sp.
	22·4	Dione.	w.
	4·1	Tethys.	w.
	4·1	Mimas.	w.
19	18·4	Rhea.	e.
	18·8	Dione.	nf.
	18·9	Tethys.	nf.
	23·7	Encel.	w.
	2·8	Tethys.	e.
	2·8	Mimas.	w.
20	20·0	Dione.	sf.
	21·6	Rhea.	inf. 10″ s.
	23·8	Dione	inf. 8″ s.
	1·5	Tethys.	w.
	2·2	Rhea.	sp.
	3·7	Dione.	sp.

The semi-axes of the apparent orbits of the five inner satellites, and of the outer rim of the ring, expressed in semi-diameters of the ball's equator.

	Ring.	Mimas.	Encel.	Tethys.	Dione.	Rhea.
Semi-major axis	2·31	3·14	4·03	4·99	6·40	8·93
Semi-minor axis.						
Dec. 1	0·36	0·49	0·63	0·78	1·00	1·39
11	0·35	0·48	0·61	0·76	0·97	1·35
21	0·34	0·46	0·59	0·73	0·93	1·30

Polar semi-diameter of the ball 0·90.

Approximate positions of the satellites may be found with the help of the list of conjunctions and elongations in the manner indicated on page 277.

Differences of right ascension and declination of Titan and Iapetus and of the centre of Saturn. At 0h. Gr. Sid. Time.

		Titan.		Iapetus.	
		α—A.	δ—D.	α—A.	δ—D.
1876.		s.	"	s.	"
Dec.	1	+10·47	— 2·0	+ 0·11	—10·1
	2	11·85	13·7	2·84	8·3
	3	11·56	23·3	5·55	6·5
	4	9·65	29·6	8·20	4·7
	5	6·41	31·8	10·80	2·8
	6	+ 2·27	29·3	13·31	— 0·9
	7	— 2·17	—22·7	15·73	+ 1·1
	8	6·28	12·7	18·03	3·1
	9	9·40	— 0·9	20·20	5·1
	10	11·02	+11·0	22·23	7·0
	11	10·84	21·0	24·11	8·9
	12	8·07	27·4	25·82	10·8
	13	5·45	29·3	27·36	12·7
	14	— 1·15	26.3	28·76	14·5
	15	+ 3·32	19·2	29·86	16·2
	16	7·26	+ 9·2	30·83	17·9
	17	10·12	— 2·1	31·61	19·5
	18	11·26	13·0	32·18	21·0
	19	11·29	22·0	32·54	22·4
	20	9·49	27·8	32·70	23·7
	21	+ 6·37	— 29·7	+32·65	+24·9

It has already been stated, on page 276, that the conjunction of Iapetus, on Dec. 2, is the last close conjunction for more than a dozen years to come.

Observers, who may have succeeded in observing the times of any of the predicted conjunctions of the satellites, will oblige by communicating their observations. A.M.

66, Lambeth Road, S.E.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Rev. J. C. Jackson, *Clarence Road, Clapton, E.*, **not later than the 15th of the Month.**

APPENDIX.

ON THE GREAT METEORS OF 1875, *SEPT.* 3, *SEPT.* 7 *AND SEPT.* 14.

By Captain G. L. Tupman, R.M.A.

It rarely happens that a brilliant meteor is observed with the accuracy necessary to enable its true path through the atmosphere to be determined with much precision. Of late years numerous and reliable results have been obtained* demonstrating the heights at which fireballs, as well as ordinary shooting stars of small magnitude, appear and disappear, and the direction of motion of numerous meteoric streams, or star showers, has been determined with very great precision, considering the nature of the phenomena.

The appearance of a fireball is so sudden and unexpected, and its duration is so transient that before the observer can begin to *think*, it is gone, and he has to trust to his memory for any particulars regarding it. If he "know the stars" he may be able to describe its path with a certain degree of accuracy; but even then in most cases he has to refer it to stars at some distance from the track, and if the meteor be very brilliant it extinguishes them, and still further increases the difficulty of describing its path. It is a fortunate circumstance when a meteor is seen to pass behind some terrestrial object, as a chimney, tree top, or the bars of a window, for then the observer can note with exactness the ground he stands on, the height of his eye, the precise point of the object struck, and being *perfectly sure* of these details (a mistake in any of them would be fatal) can, if necessary, return to the spot with an instrument, and determine the bearing and altitude of his mark. It is needless to say that this is rarely done, although the opportunities are frequent.

It will not be out of place here to remind observers that the important details to report are not those which most attract attention. Colour, brilliancy, streaming tails and explosions are of small account compared with the *path*, and the *duration* in seconds of time. Every possible care should be taken to describe the former accurately, and to *count* the latter. The most careful and experienced observer, however, does well if he secure a single point in the track with the accuracy of a degree of space, while errors of 5°, or much more, are often unavoidable. Angles, whether altitudes or distances, should never be estimated *in degrees*. Most persons (as has been often before remarked) guess altitudes at double what they really are, and "the zenith" means anything higher than 45° or so.

Of the somewhat numerous reports of the brilliant meteors of 1875, September 7 and 14†, there are several describing the path with unusual

* In this country chiefly through the untiring energy of Prof. Alexander Herschel.
† Most of which were kindly sent to me in answer to an appeal in the *Times* newspaper.

precision, and there is exceptional consistency in the estimated durations. These have yielded such good results that it cannot but be interesting to give them at length, as well as the true paths through the air and the orbits they were describing in space which I have calculated from them, on the supposition, in regard to the orbits, that they were moving in parabolas.

In all three instances the *observed* velocity (as given here) of motion through the air was found, and the mean value adopted, before the relative velocity on the assumption of parabolic motion was computed. The agreement between the observed and calculated velocities proves the correctness of adopting the parabolic orbit as the basis of calculation, and also that these small bodies were moving in ellipses of very great eccentricity. If the connection between comets and meteors had not been already demonstrated, this fact would have been very significant. As yet these and allied investigations have never led to the detection of an approximately circular orbit. The orbit of the Biela Comet Meteors, the most nearly circular yet discovered, has an eccentricity of ·75.

The method adopted in reducing these observations, which does not appear to be very generally known, is as follows:—

All the recorded paths are laid off, as portions of great circles, on a celestial globe.* These are then prolonged backwards to discover a common point of intersection which is the astronomical Radiant Point. They are also produced forwards until they meet the horizon, (the pole of the globe being set for the latitude of each observation, if necessary,) and give the azimuth on which each observer would have seen the meteor apparently strike the earth, on his own level, had it continued so far in the same direction of motion. These azimuths being plotted off on a chart representing the places of observation in their relative positions in plan on the earth (a good map in fact), should intersect one another at the spot where the meteor track produced strikes the earth. If one end of a straight line be supposed to rest upon this spot and the other to point in the direction of the astronomical radiant, such line would be coincident with the meteor's true path in the air; and the co-ordinates of the observed places of the beginning and end of the visible track, as seen at different places, would, if accurate, all indicate the same portion of this line as that which the meteor traversed. It must always happen that the terminal point is the more accurately fixed: an independent determination of the position of this point, from its own azimuths and altitudes, being therefore made, the line of motion is made to pass through it while remaining parallel to its former position, and the most accurate result possible is obtained.

If any one observer fix accurately any point whatever in the apparent path as seen by him, without the probability of a mistake—such as seeing it cross the disc of the moon, or occult a well-known star—the calculated path must satisfy such condition, and there will generally be accidental circumstances which the calculator must duly weigh. Those who have attempted these reductions only know how marvellously wild and inaccurate the descriptions often are although given with confidence.

* One of twelve inches diameter is very convenient.

Meteor of Sept. 3, *9h.* 55*m. G.M.T.*

1. The Rev. F. Simcox Lea, at Tedstone Delamere Rectory, near Worcester, lat. 52° 13½′ N., long. 2° 27′ W., at about 9h. 55m., saw, through one of the windows, a brilliant meteor fall *vertically* from altitude 25° to alt. 15°, on the true azimuth S. 35° E. The azimuth was obtained from that of distant objects shown on the ordnance map, which were immediately below the meteor. An altitude judged to be equal to that of the meteor at first appearance was measured.*

"The path, which was vertical, was only in a small arc before disappearance. I saw the whole, the clouds being only thin and fleecy. From memory it may have been somewhat more than the distance between the pointer-stars of the Great Bear; but this is only a very rough guess."

2. Mr. Lucas, of the Radcliffe Observatory, writes:—"My entry on Sept. 3, very hastily written down, was 9h. 55m., Jup. × 3. Blue to green, 5s. Saturn, nearly vertical. Path about 11° slightly eastward. Burst. Hazy."

"I had been observing with the transit circle under very unfavourable circumstances, the sky being much clouded, and went to the south door to see if there was a prospect of a clearing in time to see the meteor leave the small star just to the west of *Saturn* and pass in its course under δ Capricorni. The sky was very hazy or clouded in the south below *Saturn* so that I could not see any stars. I do not think the duration of 5s. can be much too long, as I always begin to count as soon as I can on the appearance of a meteor, and I cannot get very much out in 5s. I may be one second in excess sometimes. At disappearance it threw off a piece about the apparent size of *Saturn*."

3. G. L. Tupman, at the Royal Observatory, Greenwich, Sept. 3, 9h. 52m., G.M.T.—"I was facing S.S.W. and saw a brilliant fireball falling exactly vertically close to α Aquilæ, between α and β. Although its motion was exceedingly rapid, in falling some 20° it sensibly diminished in brightness, then burst out again with blinding intensity—for a moment almost as bright as the sun. Keeping the eyes steady fixed on the point of disappearance, after a second or two I saw it was about one degree to the left, and less than that below κ (39) Aquilæ. Duration, 1·5 to 2 seconds; colour, white; no streak. The meteor seeemed to have a diameter as large as 15 minutes, but that may have been entirely optical. It is hardly possible to mark the track of so bright a meteor more accurately than this. Neither the azimuth nor the altitude at the finish can be a degree in error.

4. Mr. E. Lawford, F.S.A., Leighton Buzzard, Sept. 3.—"On Friday evening a little before 10 o'clock, facing the S.W., I was startled by a meteor of great brilliancy shooting *downwards*. My first idea was that it was a rocket *falling*, but I am convinced from your description in the *Times* that it was the meteor which you describe, and which answers *in every way* to the brilliant object that attracted my attention." [The italics are mine.—G. L. T.]

The local co-ordinates of the path are, the meteor falling vertically everywhere:—

	True Azimuth.			Altitudes. Beginning.	End.
		°		°	°
Tedstone	S.	35	E.	25	15
Oxford	S.	12	E.	25	13
Greenwich	S.	22	W.	48	29

* This is very different from guessing the altitude in degrees.

and the radiant point was the zenith or in R.A. 311°, north declination 52°, with small error.

The azimuths intersect one another at a point 57 nautical miles south and 23 west of the Royal Observatory, or in latitude 50° 31′ N., longitude 0° 37′ W., 14 nautical miles S.S.E. of Selsey Bill in Sussex. The meteor was therefore descending vertically over this point, and from the altitudes the heights are obtained in statute miles as follows:—

	Tedstone.	Greenwich.	Oxford.
Beginning	67	78	43
End	40	39	22
Length of path	27	39	21

The Oxford observation is very discordant in altitude and duration. As seen at Greenwich the downward motion was very rapid, and appears to have been about 20 miles a second.

The neighbourhood of the radiant point has long been recognised as a point, or rather area of departure of shooting stars as the following observed positions show:—

Heis	August 31	306° + 59°
Clark	August 13	315 + 42
Greg & Herschel	August 4	310 + 47
Tupman	August 13	310 + 58
Schiapparelli from Zezioli's observations	Sept 5	319 + 53

The mean of these is 312° + 52°, a remarkable coincidence; but the propriety of taking the mean is questionable. The last, 319° + 53°, is undoubtedly identical with that of the meteor, being less than 5° distant.

The adopted radiant, 311° + 52°, gives the following elements of a parabolic orbit:—

Ascending Node	161°
Inclination	43
Perihelion distance	·911
Longitude of the perihelion	17°
Aphelion ecliptic longitude	189
Do. latitude	+24
Motion	*Direct*

In this orbit the relative velocity is 18·3 statute miles per second. The observed velocity was about 20, a perfectly accidental agreement.

Detonating Meteor of Sept. 7, 11 h. 21 m. G.M.T.

1. Mr. Wilfred Airy was driving to Ipswich along the Henley Road, at 11h. 20m. p.m. Sept. 7, and saw a very fine bluish-white meteor which started as a single ball of fire, but after about half its run parted into two. The course slanted downwards from left to right at an angle, by estimation, of something less than 45° with a horizontal line through *Altair*, very close to which star it vanished. It lasted but a short time, say two seconds at most, and lighted up the country like a big rocket at bursting. Lat. 52° 4′ N., Long. 1°. 10′ E.

2. Mr. W. A. Schultz, from the Lewisham Road (L.C.D.R.) station, on Sept. 7 at 11h. 20m. observed a meteor three times the size of Jupiter, of bluish-white colour, moving from the direction of 2° below *α* Androm.

northwards to near Capella. Duration 1·5 seconds. Fine train. It was of extreme brilliancy and emitted magnificent blue and red sparks. Lat. 51° 27′, long 0° 2′ W.

3. Mr. J. Barnaby, at Maidstone, on Sept. 7 at 11h. 23m. p.m., noticed the northern sky brightly illuminated, and looking up saw a brilliant meteor falling a little to the east of the Great Bear, which must have passed near the zenith. Its duration was nearly five seconds. Mr. Barnaby kindly revisited the spot and made a chart of the path, referred to the stars, which places the beginning in the E.N.E. (true) at an altitude of 60°, and the end N. by E. ¼ E., 32°. Lat. 51° 16′ N., long. 0° 32′ E.

4. Messrs. Lucas and Bellamy, at the Radcliffe Observatory, Oxford, on Sept. 7 at 11h. 21m. G.M.T. observed a large meteor, about twice the apparent size of Jupiter, increasing to about four times that of Jupiter, with a tail of 5°, move from near 4 Arietis to near *f* Tauri, where it burst into five or six pieces. Colour blue to green, with red at bursting Duration about 7 seconds, counted. Lat 51° 45½′ N., long. 1° 16′ W [*Nature*, 1875, Sept. 23, with additions].

5. Mr. H. Corder, Writtle, near Chelmsford. Sept. 7, at 11h. 23m.—"I did not see it at first, but heard that it rose upwards from the S.W. [? S.E.] bursting like a sky-rocket into a number of pieces, then fading away and bursting out again. At first it was of a blue colour. It was sufficiently brilliant to light up the country. When I saw it it had just passed above α Andromedæ, and was of a decided mauve tint and double. It rushed along at a great speed, with an unsteady flickering light of great brilliancy, and disappeared near the cluster in Perseus [χ]. It left no train, but was followed by a few sparks. One minute and three-quarters after disruption I heard a double explosion, like the firing of a double-barrelled gun at a distance, followed for about fifteen seconds by a rolling sound like distant thunder. (*Astronomical Register*, XII., 246.) Lat. 51° 44′ N, long. 0° 25′ E.

6. Mr. A. Lindemann, Charlton, Kent. Sept. 7, at 11h. 23m. p.m., observed a remarkable meteor, of a bright yellow colour, shoot from γ Andromedæ, between α, β Persei to near ϵ Aurigæ. Its disc was about two minutes [? degrees] in diameter. For some 30° of its path it emitted sparks, like stars of the second magnitude, to 5° or 10° behind it. About 0·2s. before it disappeared it divided in two, and at that moment the track was surrounded by bright blue light. One portion was retarded in its flight, but lasted a little longer than the other. The separation took place gradually; at the time of disappearance the two parts were six minutes [? degrees] apart. The track [streak] disappeared about half a second after the meteor, the duration of which was 1·5s. to 2s. Lat. 51° 25′ N. Long. 0° 4′ E.

7. "B. H." At Balham, Surrey, *Times*, Sept. 9, 1875. "The meteor was different from several other meteors of the first class that I had before seen, in this respect—that it was double-headed, conveying the idea of a dumb-bell of many coloured lights travelling in its axial direction and carrying a tail behind it, the whole apparition, heads and tail, being from 10° to 15° in length. I faced E.N.E. when it first appeared, its path commencing at 70° of altitude, upon a vertical line drawn through the star Aldebaran in Taurus; its course was oblique to the left, and it travelled on a line drawn from near the star Algol in Perseus, through Capella in Auriga, disappearing at an altitude of 40° in E.N.E.* The first portion of its path was hidden from view by

* When altitudes are *guessed* in degrees they are generally *to be halved*. In this case they should be 46° and 29° to accord with the description of the path referred to the stars.

the roof of the verandah beneath which I walked. The sky was without a fleck of cloud. The time was 11.20 p.m. Lat. 51° 27′ N. Long. 0° 10′ W.

8. Mr. G. Ingall, Greenhithe, Kent, *Times*, same day. "About 11.20 my brothers and myself were suddenly surprised by the night being lit up as if by lime or electric light. On looking round we found the cause to be a most splendid meteor which almost directly split in two, each piece dropping fragments behind it. Its apparent course was from the Pleiades in a slight western slant towards the earth, and disappeared, or went out, about 20 ft. from the earth, as it seemed. Its appearance was like the fireballs thrown up at the Crystal Palace—the two portions pear-shaped, with the points upwards, the thickest portions of a brilliant white shaded off at the points to red and green." Lat. 51° 27′ N. Long. 0° 10′ W.

9. Mr. T. Lynn (of the Royal Observatory), on Blackheath, *Times*, same day (corrected). "On the night of the 7th of September, as I was crossing Blackheath, the whole hemisphere appeared to be suddenly illuminated by a brilliant light, and it was a few seconds before I perceived the cause to be a splendid meteor in the east, which resembled a beautifully coloured bar of flame. While I was looking at it it passed from β Persei across the middle of the constellation Auriga, when it disappeared. I found the time to be 11·20."

From the first seven of these reports the following local co-ordinates of the path are obtained :—

Place.	Beginning.		End.		Earth-point.*
	Azimuth.	Alt.	Azimuth.	Alt.	Azimuth.
Ipswich	S. 19°W.	52°	S. 54°W.	36°	S. 80°W.
Lewisham ...	N. 86 E.	54	N. 52 E.	29	N. 34 E.
Maidstone ...	N. 22 E.	60	N. 13 E.	32	N. 9 E.
Oxford	S. 65 E.	38	S. 85 E.	18	N. 82 E.
Writtle	S. 38 E.	62	N. 58 E.	59	N. 20 E.
Charlton ...	N. 86 E.	54	N. 57 E.	29	N. 40 E.
Balham	N. 76 E.	46	N. 52 E.	29	N. 29 E.

The radiant point is satisfactorily given at 347° + 15° with a probable error of 2°, or S. 16° E., at Alt. 54°. (See the discussion of the Great Meteor of September 14, page 16.)

The azimuths of the earth-point (using the mean of Charlton and Balham as one) place it close to the middle point of the line joining Sudbury and Shalford in Essex. By comparing the terminal altitudes in pairs, and giving double weight to Ipswich and Writtle from their proximity and precision of description, a much more accurate position is found for the point of disappearance, over latitude 51° 47′, longitude 0° 43′ E. (5 miles E.S.E. of Witham) at the height of 22 statute miles.

The individual determinations of this height are :—

* The "Earth-Point" is the place where the meteor-track produced meets the surface of the earth. It is so called by Professor A. S. Herschel.

Ipswich	19·6	statute miles.
Lewisham	22·0	„
Maidstone	23·0	„
Oxford	27.6	„
Writtle	22·0	„
Charlton	21·3	„
Balham	24·1	„
Mean, rejecting Oxford,	22·0	„

Oxford is rejected because it is much more distant than the other stations ; an error in the altitude in degrees produces double the numerical effect on the height in miles.

The direction of motion given by the radiant point, viz., S. 16° E., altitude 54°, in combination with the terminal point just found determines the exact position of the earth-point and the line on which the meteor must first have appeared. At Lewisham and Oxford it was first seen at the height of 82 st. miles, already very bright, immediately over the middle point between Ashford and Hythe in Kent. The observer at Writtle next saw it at a height of 67 miles over Faversham. It had two heads, one close behind the other, or divided itself at mid-course, the two parts slowly increasing their distance apart by retardation of the hindermost, as they rushed through some 50 miles in something under three seconds of time. This appears to be a proof of sensible retardation by the density of the atmosphere, although its pressure could hardly have exceeded two-tenths of an inch of mercury. Had the meteor remained in existence another second it would have fallen into the village of Castle Hedingham, about 5 miles S.W. of Sudbury. The heated matter left behind it in the form of a tail was visible along 10 or 15 miles of its path.

The following table shows the theoretical local co-ordinates required to satisfy the above path for comparison with those observed on page 6 :—

Place.	Beginning.		End.	
	Azimuth.	Alt.	Azimuth.	Alt.
Ipswich	S. 18°W.	51°	S. 47°W.	38°
Lewisham ...	N. 87 E.	54	N. 55 E.	30
Maidstone ...	N. 25 E.	60	N. 10 E.	31
Oxford	S. 66 E.	38	N. 88 E.	13
Writtle	S. 38 E	63	N. 70 E.	60
Charlton ...	N. 76 E.	54	N. 47 E.	31
Balham	N. 78 E.	46	N. 57 E.	26

In this table the local beginning is chosen as near as possible to that observed, but the end is the same for all. It is very exceptional to find ch agreement with observation as is here shown.

Mr. Henry Corder, at Writtle, one minute and three quarters after the apparition, heard a sound like the firing of a double-barrelled gun at a distance, and for a quarter of a minute afterwards a rolling like thunder. The terminal point was 25 st. miles distant from him, a space which sound would require exactly two minutes to traverse. It is certain, therefore, that the sound was produced by the meteor (each half perhaps causing a distinct sound), at, or nearly at, its terminal point. It is puzzling to account for the production of a sound so intense in a medium so rare as the air at 22 miles from the surface. A bonâ fide *explosion* is very improbable if the body be small enough to be entirely consumed in a few seconds, as is the case with most "detonating" meteors.

The velocity of the meteor's motion is given very differently from the various estimates of the duration—as is generally the case.

The observation at

Ipswich	gives	20	miles per second, or less.
Lewisham	„	45	„
Maidstone	„	15	„
Oxford	„	13	„
Balham	„	17	„

Allowing the observed duration at Lewisham to apply to the average length of path instead of to the very long one recorded there, the above velocity of 45 would become 25 miles per second. One second has been deducted from the Oxford duration. The mean velocity is 18 miles per second, which is probably within 5 miles of the truth.

Seen from Greenhithe the meteor passed over the cluster in Perseus (χ), which Mr. Ingall no doubt mistook for the Pleiades. It disappeared at an altitude of 37°—described as about 20 *feet* above the ground.

From Blackheath it passed a few degrees over β Persei and just entered the constellation of Auriga.

Great Detonating Meteor of Sept. 14, *8h. 27m. G.M.T.*

1. G. L. Tupman.—Half-a-mile east of the Royal Observatory, Greenwich, on Sept. 14 at 8h. 27¼m. G.M.T. I saw a fine fireball descending slowly from the north in the direction of the minute hand of a clock when it is at 40 minutes. The full moon was shining brightly behind me, overpowering the small stars, so that I could not note its path accurately. It disappeared behind the corner of a house perhaps 100 yards from me. Holding my stick up at the proper slant the path carried backwards seemed to cut γ or δ Cassiopeia, or pass a trifle below them. α Urs. Maj. was nearly over the corner of the house, but a trifle to the left; a minute or two afterwards I took careful notice of the ground I was standing on, and of the house, and afterwards found the corner to be in the true azimuth N 17° W., and the spot where the meteor appeared to strike it was 9½° above the horizon (measured with an instrument). The fireball was very bright, but of ordinary appearance, three or four times brighter than *Venus*, long train, left no streak, colour white, motion slow and stately. It was about under Polaris when I first saw it, and I estimated the duration as 2 seconds, perhaps more. I did not count. Lieut. Neate, R.N., saw it from the Observatory grounds, but lost it behind a roof at mid-course, after seeing it for 2 seconds. Colour deep yellow, with red lower edge. Time 8.27. Lat. 51° 28½′. Long. 0° 1′ E.

2. Rev. F. Simcox Lea, Tedstone Delamere Rectory, near Worcester, saw the meteor for about a second crossing an opening in the trees from

right to left, at about the same altitude as the moon (16°). It was found afterwards that the azimuths were N. 59° E. and N. 48° E. (true). Lat. 52° 13′ N. Long. 2° 27′ W.

3. Rev. T. J. Smith, Tram Inn Station (5 miles from Hereford).—Sept. 14, 8.30 p.m. Bright moonlight, no clouds, calm. A splendid meteor started from the position of γ Androm., passed south of α Persei, north of Capella, and extinguished near β Aurigæ. Its head was a beautiful greenish blue, of intense brightness even in the strong moonlight. The train narrow and straight of red sparks which continued longer than the light of the head. It appeared to extinguish without any detonation. Estimated period of transit 10 seconds. About 3 minutes after its passage very light cirrus clouds formed over its track, obscuring the stars for about 2 minutes, then dispersed. Latitude 52° 0′. Longitude 2° 47′ W.

4. Mr. J. J. Allinson, Lynn, Norfolk. Sept. 7.—"At 8·20 p.m., the moon shining brilliantly in a cloudless and clear sky, I saw, very low down in the eastern heavens, a bright meteor of a pale bluish colour, 3 or 4 times the size, and 2 or 3 times the brightness, of *Venus* at her largest and brightest. The bearing was about E. by N., and it seemed moving in a northerly direction, but by its getting larger, to be approaching the spot where I was standing. I should say it disappeared before reaching the horizon.*

"About four or five minutes afterwards, whilst looking in a south-westerly direction, I was attracted by a bright light in the north-western sky, and on looking towards that quarter observed a most splendid meteor, about the size and colour of the first, but much more brilliant, descending from a point in the neighbourhood of the last of the three stars in the tail of the Great Bear in an almost vertical, but, I should say, somewhat irregular course. I thought it rather pear-shaped. I was standing on the top of a railway bridge, and unfortunately a train passed just at the moment, the steam from which somewhat obscured my vision. The meteor disappeared when about halfway between the point at which I first observed it and the horizon."

[Mr. Allinson kindly revisited the spot and traced the track on a chart of the stars, from which it appears that the meteor became visible in N. 54° W., altitude 35°, and disappeared in N. 53° W., 17°., but the track really continued nearly to the horizon.—G. L. T.]

5. Mr. S. H. Miller; a few miles N.E. of Wisbeach. Sept. 14, 8.25 p.m.—"I was driving towards the west and the moon shining brightly in a cloudless sky when my attention was attracted towards the north by the bright light of this beautiful meteor. It appeared to me to pass between β and θ of Ursa Major towards λ.† At first it was as large as *Venus* three times magnified, and of a blue colour. In about a second it passed into the *pear-shape*, leaving a thin streak behind it; in another second it diminished to the size of a star of 3rd magnitude and appeared yellow. There was no explosion, but it disappeared about 15° from the horizon." Latitude 52° 44′ N. Longitude 0° 11′ E.

Another observer, "E. G.," at Wisbeach, noticed the meteor, at 8.25, pass from the vicinity of Cassiopeia to Ursa Major, where it suddenly disappeared. The tail was "forked," and of green, red and yellow hues.

* There is little doubt that this meteor belonged to the same system as the one under discussion.—[G. L. T.]

† This course is not reconcilable with the true path. It requires to be shifted, parallel to itself, 20° to the westward. "E. G.'s" observation, on the other hand, is perfectly accordant if the two constellations be considered as represented by their 5 or 6 principal stars.

6. "L. B. P."; a few miles N. of Carlisle. Sept. 14.—"Driving on Tuesday night from Longtown to Carlisle, at 8.25, a meteor of most dazzling brightness caught my eye. I saw it first apparently in close proximity to the full moon, which by the side of the meteor appeared quite pale. In colour it was not unlike a Roman candle. Its duration was, I should think, from 10 to 15 seconds. In size it was compared by two of our party to a cricket-ball. It moved very slowly through the sky in a direction straight from the moon, westwards and downwards, or from north-north-east to south-south-west."*—*Times*, 1875, Sept. 16. Latitude 54.56. Longitude 2° 56′ W.

7. Mr. S. Knight, A.R.I.B.A., Teignmouth. Sept. 14, 8.27 p.m.—"It appeared to me to commence at a point about 30° from the horizon beneath Cassiopeia, and thence descended in a northerly direction, disappearing from view behind the tops of some hills about 250 or 300 feet above the sea level and 2 miles distant [Mr. Knight was walking on the sea shore], and at a point very nearly under the Pole star. Its course appeared to be a long flat curve concave to the horizon.

"It commenced with a rocket-like outburst, from which proceeded a fireball, changing brilliantly in colour from yellow to red and blue, emitting slight coruscations, but without much *tail*, increasing in intensity and size for about one half its course, appearing to be $\frac{1}{4}$ or $\frac{1}{5}$ the diameter of the full moon (then shining brilliantly). It then rapidly decreased in brilliancy and size, descending behind the hill a whitish orb similar to Venus. It was remarkable to me for its *slowness* of motion, as it occupied from 6 to 8 seconds; and the manner in which its flight seemed to be retarded towards the close led me to infer this effect was due to its course being *away* from my point of view, and that the diminished brilliancy and speed was due to perspective. There was no tail after disappearance." Latitude 50° 32′·5. Longitude 3° 29′ W.

8. Mr. W. M. Burman, L.R.C.P., &c., Wath, near Rotherham.—"The magnificent meteor of Tuesday night, Sept. 14th, was well seen here in a cloudless sky, at 8.26 G.M.T. I was walking, and the full moon was throwing my shadow on a wall on my right, when suddenly a dazzling light shone around, and my shadow vanished from the wall. Upon looking up I saw this magnificent meteor slowly careering across the sky, quite overpowering the light of the moon. It passed nearly overhead and disappeared in the N.W. by W. It was of a half-moon shape, the preceding part being convex and sharp, the following part flame-like and flickering, and of a brilliant bluish-white colour. No red tinge was seen from first to last, nor train, nor sparks. Its diameter was about half that of the moon. In that dazzling light it was impossible to see any star, but soon after it had passed I tried to make out its path. It must have been when I first saw it about midway between Beta Pegasi and Alpha Andromedæ, perhaps rather nearer the latter; then it passed through the midst of the 5 principal stars of Cassiopeia, then through Camelopardalus into Ursa Major between '23' and Theta†, finally disappearing midway between Gamma Ursa Majoris and the horizon in the N.W. by W. Whilst it was still in sight I noticed that its course, if produced backwards, would pass from 5° to 10° above the moon. Its total visibility was about 6 seconds, but I only saw it during 4 or 4½ seconds as it went behind the roof of an adjacent house; but a friend at

* The expression "from N.N.E. to S.S.W." has been accepted as referring to the astronomical position angle, which agrees with "westwards and downwards," the meteor moving along in the direction of the minute hand of a clock when at the 20, the moon being the centre of the clock.

† It could not have been "23."—G.L.T.

about half a mile south-west from my position saw it disappear directly in front of him in the situation I have described. He says it simply disappeared, no sparks being visible, nor any change of colour.

"Three and a half minutes after it disappeared I heard a sharp and sudden explosion like the report of a small cannon at a distance, exactly from the direction which the meteor had taken, but whether it had anything to do with the meteor or not I cannot tell. The rumbling of a distant train prevented me from hearing any sound during the passage of the meteor if any such was audible, as asserted by 'J. L., of Bath' in Thursday's *Times*." Latitude 53° 30′ N. Longitude 1° 21′ W.

9. Rev. H. L. Elliot, Gosfield Vicarage, Halstead.—"On Monday, Sept. 14, 1875, at about 8 30 p.m., a large and brilliant meteor presenting an appearance like iron at white heat, and leaving a train of red spots, was seen from this place to cross, in a downward direction, and at an angle of about 60° with the horizon, the constellation of the Great Bear, passing to the west of, and near to the N.E. star. It was visible about 4 seconds of time, and for about 40° of angular space, and passed with a majestic and apparent upward sweep behind the trees which shut in the horizon at about half a mile distance." Latitude 51° 56′. Longitude 0° 36′ E.

10. Mr. W. Dundas, Faringdon, Berks. Sept. 14.—"About 8.26 p.m., while walking in my garden, my attention was attracted by a distant *hissing* sound, and looking up I saw the meteor, of intense brightness, at about ¼ of the distance from horizon to zenith, and (judging by the Pole star) about 2 points east of north. It sailed slowly along and disappeared behind some large trees which prevented my seeing whether it maintained its brilliancy to the horizon. I last saw it about 1½ points west of north, by which time it seemed to have descended about half the height at which it was when I first saw it.

"It was followed by a divergent double train of brilliant light, and I feel firmly convinced was accompanied by an audible hissing sound; indeed my impression at the moment was, as I have said, that my attention was first attracted by the sound. (See No. 14.)

"The sky above was cloudless, but shortly before I lost sight of it some heavy clouds, low in the sky (and before and after invisible), were brightly displayed as it passed them. To me it seemed at the time as if the meteor passed *between* me and them, and that the light on them was *reflected*, not *transmitted*. Of course, if the meteor was seen also at Bath, it could not be so; but it suffered no visible diminution of brilliancy while passing these clouds.

"The light was an intense bright white light, more like that of magnesian wire than any other I can name." Lat. 51° 40′. Long. 1° 35′ W.

11. Mr. J. W. Proctor, near York. Sept. 14.—"A friend of mine and myself were driving home near to Grimstone, 3 miles to S.E. of York, at 8.20 to 8.30 p.m. on the above night.

"The moon might be, I should guess, 40° to 45° above the horizon.* We were suddenly startled by a glare of light upon the ground, already pretty well lighted up by the moon, and quickly raising our eyes caught sight of a most splendid meteor coming from the direction of the moon. I imagine it must have been first visible 10° or 15° below [? above] the moon to the S.E. before we saw it, from the glare which first called our attention. It then proceeded in a north-westerly direction, keeping to the W. of our zenith and disappeared perhaps 40° above the horizon to the N.W.

* The altitude of the moon was, in fact, 16°.

"The nucleus, which was of the same coloured light as the moon and brighter in degree, was at the front, with a diameter we estimated at $\frac{1}{4}$ to $\frac{1}{3}$ the apparent diameter of the moon. A tail followed it, of considerable brilliancy (but less), and of a much redder cast, extending so as in all to make about the same length as the diameter of the moon. I did not observe any trace at much greater distance than this behind. The time occupied was perhaps 10 to 20 seconds. I have some impression that it was accompanied or followed by a rushing sound, and a friend of mine thought the same, but amounting to an explosion at a great distance. The meteor died away very suddenly."

12. Mr. J. T. Seccombe, Terrington, Norfolk. Sept. 14, 8h. 20m.—"I was driving on the Walpole road at that time, the nearly full harvest moon being on my left, about 30° above the horizon, and the sky cloudless, when I was astonished at seeing on my left the heavy shadow of myself and gig. As the moon was on that side of me I immediately turned to the opposite direction, and there saw a splendid blue meteor moving directly towards the horizon.

"This meteor gave a light which I judge must have been twice that of the nearly full moon, and from what I learnt afterwards, it was first seen near the zenith, and passed not far from beta Ursæ Minoris, and epsilon Ursæ Majoris, leaving a long train behind it." Lat. 52° 46′. Long. 0° 17′ E.

13. "W. W. H." Sudbury, Suffolk.—"On Tuesday evening, about 8.20, I observed a fine meteor of unusual brilliancy. When I first saw it it was proceeding from the circum-polar region in the direction of the 'pointers' in Ursa Major, which it almost eclipsed in its descent. A clump of trees prevented my ascertaining whether it descended to the horizon, but from glimpses I caught through the branches I believe it did. The 'shooting star' itself was very large and bright, and attached was a long tail, broken at about a third of its length from the end into dashes and dots of bright colours, leaving a white track behind for several seconds after the meteor itself had disappeared. It was bright moonlight, and the moon nearly at the full, yet the meteor quite lit up the northern sky in its passage."—*Times*, Sept. 16. Lat. 52° 3′. Long. 0° 43′ E.

14. "J. L.," Bath.—"On Tuesday evening, at 8.25, while standing in the front of my house, which faces the north, I saw a meteor, apparently about half the size of the moon, but of oblong shape, of various colours. It was not far above the horizon, and took a diagonal path from east to west, falling in all its blazing splendour on the earth. It could not have been very far, as I distinctly heard a slight continued hissing* as it rushed through the air. All the time the sky was cloudless, the moon shining with all her brilliancy."—*Times*, Sept. 16. Lat. 51° 23′. Long. 2° 23′ W.

15. Mr. E. Ledger, Duxford, near Cambridge. Sept. 14.—"It may interest you to hear that the sparks of it were so brilliant that my groom, sitting in his room, which has a good north aspect, saw not only the meteor, but the sparks also, *through* an ordinary white calico *blind*, which was *down* at the time. He then looked out and judged that it had

* I can offer no explanation in regard to this *hissing sound* so distinctly heard by Mr. W. Dundas (Report No. 10), and by "J. L." The meteor was certainly 150 miles distant, which sound would require about 12 minutes to traverse. Once, when lying at anchor in the River Plate, in the small hours of the morning, all around being absolutely still, I saw a shooting star of about the first magnitude, traverse some 40° of the sky, and less than a second after I heard a gentle hissing sound, from its direction, which greatly astonished me.—[G. L. T.]

descended as near as he could tell through δ and γ of Ursa Major. As it appeared to get down to the bottom of the blind he says it grew smaller in size and disappeared before reaching the bottom, which would be near to the horizon."

16. Rev. W. E. Edwards, Orleton Vicarage, Ludlow. Sept. 14.—"What I saw was this: A mass of white fire in shape like a small tumbler with the larger end first, a dark space of ½ inch, then a tail of brilliant green about 12 or 14 inches, at the end of this a dull red mass as of ashes falling down. One of the boys at once described it as ashes dribbling through his fingers. We walked several steps, ten or twelve, whilst it passed with a slow undulating motion from south-east to north-west, I looked at my watch; it was 8.22 'station time.' The apparent pace was that of a rook flying homewards.

"It faded suddenly without explosion or noise."

17. Mr. T. W. Grey, Manchester. Sept. 14, 8.27.—"The nucleus appeared to be of about ⅔ that of the moon, the colour resembling the magnesium light, the tail apparently about 2 or 3 yards (*sic*) in length, of a ruddy colour; the part immediately in contact with the nucleus resembled ordinary fire. I heard no noise. The head was excessively brilliant. I first saw it very near the moon, whence it proceeded in a northerly course, parallel with the earth's surface, about 60°* above the eastern horizon. Its speed for a meteor was slow. It remained in sight about 7 seconds, until it disappeared behind the houses."

18. A correspondent of another paper quoted in the *Northumberland Daily Express.* 1875, Sept. 17.—"There was a tree in the passage, and suddenly I found myself surrounded by a wonderfully bright light, and the shadow of the tree was cast on the wall on my left, every leaf and twig more distinctly than in the sunshine. I was quite startled and bewildered at first by the sudden light and the shadow of the tree moving quickly along the wall, showing that the light was moving. I looked up to a window of the house, supposing the light proceeded from thence, but I perceived that it came from beyond the house, so I stepped back four or five paces to the corner, and was just in time to see a most brilliant meteor descending towards the earth. It appeared to be two or three times as large as a cricket ball, emitting a wonderful bright white light, so intense that when it ceased I felt almost blinded. It did not burst or explode in any way, but gradually diminished till it became extinct. It was, as well as I can judge, about due north-west, and its light must have lasted at least five or six seconds. It disappeared at an angle of probably 30 degrees from the horizon. When I entered the house it was just half-past eight by my watch." [No name, no locality given. The long duration, as well as the great intensity of the light, is well proved by this interesting report. G. L. T.]

19. Mr. J. King Watts, St. Ives, Huntingdon. Sept. 14, 8h. 26m. p.m.—"A most beautiful meteor suddenly started into view from Ursa Major, immediately opposite to the moon. It travelled slowly, and was of the most intense bright white light, was round, and five or six times the size of any of the planets. The sky was clear and cloudless; we were travelling between the moon and the meteor, and our shadows on the road caused by the moon were of course large and clear, but those caused by the meteor were more clear and more sharply defined. After travelling for several seconds it suddenly disappeared. A few faint white sparks were visible."

* When east of Manchester the meteor was 32° above the horizon, and at no part of its course rose any higher.

20. At Bridport, in Dorsetshire, the meteor was seen by several persons to begin in the N.E. and descend nearly to the horizon in the north. It was described as being as bright as the moon, of a blue colour, like a double Roman candle, very large, ten times the size of Venus. Duration 9 seconds.

The following local co-ordinates are obtained from these descriptions:—

	Observed Beginning.		Observed End.		Azimuth of Earth-Point.
	Azimuth.	Alt.	Azimuth.	Alt.	
Greenwich ...	North.	22°	N. 18° W.	9·5°	N. 27° W.
Tedstone Dela-	N. 59° E.	18	N. 48 E.	15	—
Hereford [mere	N. 62 E.	32	N. 22 E.	12	N. 3 E.
Lynn	N. 54 W.	35	N. 53 W.	17	N. 51 W.
Carlisle	S. 43 E.	14	S. 35 E.	10	S. 26 E.
Teignmouth ...	N. 50 E.	30	North.	1·5	North.
Wath	S. 77 E.	47	N. 32 W.	14	N. 40 W.
Gosfield	N. 10 W.	40:	N. 35 W.	8:	N. 40 W.
Farringdon ...	N. 22 E.	30:	N. 17 W.	15:	—
York	S.E.	30:	N.W.	15:	—
Terrington ...	N. 24 W.	54	—	—	N. 51 W.
Sudbury	N. 22 W.	27	N. 39 W.	3	N. 36 W.
Bath	—	—	—	0	—

The radiant point is found to be in R. A. 348°, on the equator, with a probable error of 2°, and in Yorkshire would appear in the Azimuth S. 56° E., and altitude 24°.

The azimuths of the Earth Point indicate the neighbourhood of Sedburgh, in the N.W. corner of the West Riding, as the approximate position; but on account of the great distance of most of the observers, the lines do not intersect one another very accurately. The terminal point, however, is well fixed over a point about 5 miles W.S.W. of Pately Bridge, also in the West Riding. In adopting the true path from a consideration of all the observations, it must be made to satisfy, absolutely, the observation at Greenwich which made it pass through an accurately determined point. The terminal height in miles is reduced to narrow limits of error by the observations at Teignmouth, Sudbury and Bath, where it was seen to attain the visible horizon, and those at Gosfield and Wath, which are very precise. These conditions are all exceedingly well satisfied by the following true path:—

The meteor was first seen, already very brilliant, as that of Sept. 7, at a height of 63 statute miles over the village of Hindringham, in Norfolk (Lat. 52° 53′ N., Long. 0° 56′ E.) It proceeded in a straight line, directed to N. 56° W., and inclined about 24° to the surface of the earth, to a point over Lat. 54° 3′ N., Long. 1° 53′·5 W.,* where, at 13·8 statute miles from the surface, it also burst, or otherwise produced a loud sound resembling the discharge of a small cannon, and was seen no more. Mr. Burman, at Wath, heard the sound 3¾ minutes after the

*** Over Appletreewick Moor, two miles north of Barden Fell.**

disappearance. The exact time required by sound to traverse the distance assumed would be 3m. 47s. It is probable that Mr. J. W. Proctor, near York (Report No. 11), also heard the detonation.

The course of the meteor was directed straight upon the town of Sedburgh.

Its astonishing brilliancy, as seen at moderate distances, is fully described in the reports. The diminution of the light of fireballs as seen at increasing distances, appears to be very rapid.

The following table shows the theoretical local apparent paths, founded on the above true path (having regard to the curvature of the earth), for comparison with the observed co-ordinates on page 14:—

Place of Observation.	Beginning.		End.		Azimuth of Earth Point.
	Azimuth.	Alt.	Azimuth.	Alt.	
Greenwich ...	N 2° W.	24°	N. 18° W.	9.3°[1]	N. 29° W.
Tedstone Delamere	N. 56 E.	23	N. 48 E.	21·[2]	North
Hereford	N. 66 E.	24	N. 25 E.	9·	N. 5 E.
Lynn	N. 37 W.	35	N. 45 W.	17·	N. 49 W.
Carlisle	S. 43 E.	15	S. 36½ E.	11·[3]	S. 22 E.
Teignmouth ...	N. 52 E.	16	N. 16 E.	1·7[4]	N. 10 E.
Wath	S. 77 E.	47	N. 32 W.	17·	N. 41 W.
Gosfield	N. 8 W.	38	N. 36 W.	7·2	N. 39 W.
Farringdon ...	N. 25½ E.	21	N. 1 E.	7·3	N. 12 W.
York	S. 46 E.	39	N. 78 W.	21·	N. 68 W.
Terrington ...	N. 24 W.	53	N. 46 W.	5·3	N. 49 W.
Sudbury	N. 22 W.	32	N. 40 W.	3·5	N. 41½ W.
Bath	—	—	—	3·	—
Wisbeach... ...	N. 9 E.	66	N. 44 W.	5·2	N. 46 W.
Bridport	N. 38 E.	16	N. 9 E.	1·9	N. 3 E.

[1] The corner of the house.
[2] An error in the azimuths of a few degrees would explain the discrepancy in altitude.
[3] The agreement here is accidental in great measure.
[4] The top of the hill. The azimuths were about a point in error.

The mean of nine estimations of the duration is eight seconds, corresponding to a length of track of about 121 miles. The velocity of motion therefore appears to have been 15 miles a second, and this is certainly not far from the truth.

The astronomical radiant point is within 15°, possibly within 10°, of that of the meteor of September 7. The two meteors were also similar in character, and they appear to have moved with nearly equal velocity —something under 20 miles a second. The observed radiant points give the following elements of their parabolic orbits :—

		Meteor of Sept. 7.		Meteor of Sept. 14.
Ascending Node	... ...	165°	...	$172\frac{1}{3}^\circ$
Inclination	... ...	$23\frac{1}{3}$	...	$4\frac{1}{3}$
Perihelion distance	... ...	·428	...	·366
Longitude of the perihelion	... ...	$83\frac{1}{3}$	...	$74\frac{1}{3}$
Aphelion ecliptic longitude	... ...	264	...	$254\frac{1}{3}$
" " latitude	... ...	+23	...	$-4\frac{1}{3}$
Motion	... ...	Direct.		Direct.
Relative velocity (statute miles)	...	20·5	...	16·9

There is a great similarity in these two sets of elements, and by altering the adopted places of the radiants in the proper directions by allowable quantities they could be made to approach each other a little closer, but not much.

This part of the heavens has also been known for many years as a radiant region for shooting stars at this period of the year.

Dr. Heis found for Sept.	$343^\circ + 10^\circ$	
Messrs. Greg & Herschel, Sept.	$344 + 12$	
Dr. Schmidt, Sept. 3-14	$346 + 3$	$\}$ $345 + 0$
" Sept.	$344 - 3$	
Tupman, 1871, Sept. 7-15	$345 + 13$	

The mean of the two found by Dr. Schmidt is within 3° of the Sept. 14 fireball radiant, and the mean of the other three is as close to the Sept. 7 radiant. The old positions therefore receive a genuine and unexpected confirmation from these two fireballs, the radiants obtained for which are certainly quite as accurate as the others, and merit being classed as new determinations.

If the above two orbits be projected on the plane of the ecliptic, or one on the plane of the other, those parts of them near the descending nodes are sensibly parallel, though more than ten millions of miles apart; and this at first sight indicates an antecedent physical connection or common origin. The relative inclination, which cannot be less 15° and may be 20°, and other less important differences in the elements, may easily be supposed to have been caused ages ago by a very near approach of one or other of the bodies to one of the planets, most likely the Earth itself, as just before all previous perihelion passages both bodies exactly intersected the orbit of the earth.

By no means an unimportant result of the preceding investigation is the established connection, by similarity of orbit, between certain showers of ordinary shooting stars and these large fireballs. I am unable to understand on what grounds the connection between these *apparently* different phenomena is disputed. The well known streams, whose centres of radiation are situated in *Leo, Perseus* and *Gemini* yield indiscriminately the largest fireballs and the most minute shooting stars.

Certain large fireballs, the orbits of which have been approximately ascertained, appear to be, or rather to have been, solitary in space; but, in the present state of our knowledge, this deduction does not seem to me to be significant.

Royal Observatory, Greenwich:
1876, March 27.